

Chevron Perth Amboy Refinery
1200 State Street
Perth Amboy, NJ 08861



Supplemental RFI Report
Chevron Perth Amboy Facility, NJ

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Prepared By:

Science Applications International Corporation
Two University Plaza, Suite 406
Hackensack, NJ 07601

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Acronyms

°C	Degrees Celsius
µg/L	Micrograms Per Liter (ppb)
1,1,1-TCA	1,1,1-Trichloroethane
1,1-DCA	1,1-Dichloroethane
1,1-DCE	1,1-Dichlorethene
AF	Amboy Field
AHC	Amerada Hess Corporation
AOC	Area of Concern
AOI	Area of Investigation
ARC	Alternative Remedial Criteria
ASARCO	American Smelting and Refining Company
BEE	Baseline Ecological Evaluation
bgs	Below Ground Surface
BTEX	Benzene, Toluene, Ethylbenzene, and Xylene
CAS.	Chemical Sbstracts Service Number
CEA	Classification Exception Area
CEMC	Chevron Environmental Management Company
cis-DCE	cis-1,2-Dichloroethene
cm/s	Centimeters Per Second
CMS	Corrective Measures Study
COC	Contaminants of Concern
COPEC	Constituents of Potential Environmental Concern
CPT	Cone Penetrometer
CSIA	Carbon Specific Isotope Analysis
CVOC	Chlorinated Volatile Organic Compound
CY	Central Yard
DAF	Dilution Attenuation Factor
DEHP	Diethylhexyl Phthalate or Bis(2-ethylhexyl)phthalate
DNAPL	Dense Non-Aqueous Phase Liquid
DO	Dissolved Oxygen
DPT	Direct Push Technology
DTW	Depth to Water
DWP	Dynamic Work Plan
EPA	Environmental Protection Agency
ER-L	Effects Range - Low
ER-M	Effects Range - Medium
EY	East Yard
EYB	East Yard Basin

FH	Falling Head Test
FID	Flame Ionization Detector
ft. bgs	Feet Below Ground Surface
ft/ft	Feet Per Feet
ft/yr	Feet Per Year
GC	Gas Chromatograph
GIS	Geographical Information System
GPS	Global Positioning System
GWQC	Groundwater Quality Criteria
HDPE	High Density Polyethylene
HSWA	Hazardous and Solid Waste Amendments
IGWSCC	Impact to Groundwater Soil Cleanup Criteria
LNAPL	Light Non Aqueous Phase Liquid
MDL	Method Detection Limit
MEK	Methyl Ethyl Ketone
mg/kg	Milligrams Per Kilogram (ppm)
MIP	Membrane Interface Probe
ml/min	Milliliters Per Minute
MPE	Measuring Point Elevation
MTBE	Methyl Tert-Butyl Ether
mV	Millivolts
MY	Main Yard
N/A	Not Applicable
NF	North Field
NF/MY	North Field/Main Yard
NFA	No Further Action
NFB	North Field Basin
NFE	North Field Extension
NFI	No Further Investigation
NGVD	National Geodetic Vertical Datum
NJDEP	New Jersey Department of Environmental Protection
NOAA	National Oceanic and Atmospheric Administration
NRDSCC	Non-Residential Direct Contact Soil Cleanup Criteria
ORP	Oxidation/Reduction Potential
OVM	Organic Vapor Monitor
PAH	Polycyclic Aromatic Hydrocarbon
PAOC	Potential Area of Concern
PCE	Tetrachloroethene

PCP	Pentachlorophenol
PDBS	Passive Diffusion Bag Sampler
PDI	Preliminary Design Investigation
PID	Photo Ionization Detector
ppb	Parts Per Billion
ppm	Parts Per Million
PQL	Practical Quantitation Level
PRG	Preliminary Remediation Goal
PVC	Poly-Vinyl Chloride
QA/QC	Quality Assurance/Quality Control
RBC	Risk-Based Concentration
RDSCC	Residential Direct Contact Soil Cleanup Criteria
RFI	RCRA Facility Investigation
RIR	Remedial Investigation Report
S	Slug Test
SAP	Sampling and Analysis Plan
SAR	SWMU/AOC Assessment Report
SCC	Soil Cleanup Criteria
SI	Site Investigation
SRFI	Supplemental RFI
SSG	Sediment Screening Guideline
SVOC	Semi-Volatile Organic Compound
SWMU	Solid Waste Management Unit
TAL	Target Analyte List
TCE	Trichloroethene
TCL	Target Constituent List
TDS	Total Dissolved Solids
TEL	Tetra-Ethyl Lead
TIC	Tentatively Identified Compound
TOC	Total Organic Contaminant
TOL	Total Organic Lead
TOS	Top of Screen
TPHC	Total Petroleum Hydrocarbons
TVOC	Total Volatile Organic Contaminant
USCS	Unified Soil Classification System
VC	Vinyl Chloride
VOC	Volatile Organic Compound
WQIP	Water Quality Indicator Parameters
WY	West Yard

XRF

X-Ray Fluorescence

1. Introduction

On January 21, 2005, Chevron Environmental Management Company (CEMC) received comments on the RCRA Facility Investigation (RFI) Report submitted in October 2003 from the Environmental Protection Agency (EPA) and the New Jersey Department of Environmental Protection (NJDEP) (USEPA, 2005). This letter contains CEMC's response to those comments as well as an update to previous recommendations presented in the Solid Waste Management Unit (SWMU)/Area of Concern (AOC) Assessment Reports (SARs) (Chevron, 2007a) and Potential Area of Concern (PAOC) Report (Chevron 2007b), submitted in February 2007 and June 2007 respectively to EPA and NJDEP. In order to address the EPA and NJDEP comments on the RFI Report, CEMC conducted additional subsurface investigations at the site including the installation of 136 additional soil borings and the installation of 26 additional monitoring wells. Below is a brief summation of events and activities that have transpired since January 2005 to address EPA and NJDEP comments on the RFI Report.

On August 25, 2005, CEMC met with the EPA and NJDEP Case Team to discuss the comments on the RFI Report. At this meeting, it was mutually agreed that Chevron would address each RFI Report comment in this Supplemental RFI (SRFI) Report. This decision was based on the fact that most of the RFI comments required either further delineation of contaminants of concern (COCs) or a better understanding of the local hydrogeology. To do so, Chevron re-examined their extensive database and developed a graphical presentation of the property utilizing a geographical information system (GIS). GIS allowed Chevron to better integrate both geologic and contaminant data in a three-dimensional format. This three-dimensional representation of the site was utilized to identify data gaps and to develop dynamic work plans (DWPs) to conduct additional field activities to fill them. Due to the close proximity of several of the SWMUs/AOCs and potential commingling of contaminants in the North Field and Main Yard (NF/MY), Chevron and the Agencies agreed to group some of the individual units in order to conduct further investigations more efficiently.

At the same August 25, 2005 meeting, CEMC submitted the AOC 36 Triad-Based Chlorinated Plume Investigation Report (Chevron, 2005) to representatives of the EPA and NJDEP for formal review. AOC 36 was generated as a result of the RFI and was the focus of several EPA and NJDEP RFI comments. On March 6, 2006, CEMC submitted a supplemental report to EPA and NJDEP (Chevron, 2006a) that focused on an additional field investigation on the nearby Sylvan property to provide better delineation of the chlorinated compounds previously found in that area downgradient of the Chevron property. On May 8, 2006, CEMC received letters from EPA and NJDEP stating that CEMC's recommendations to continue monitoring the groundwater at AOC 36 until July 2006 was acceptable, that delineation had been achieved, and that the chlorinated plume does not pose a risk for vapor intrusion to any off-site properties.

On July 13, 2006, CEMC met the newest member of the NJDEP Case Team, Anne Pavelka, and an agreement was made to group most of the RCRA waste management units in the NF/MY to conduct further investigations more efficiently. These eight new

groupings are identified as Areas of Investigation (AOIs) across the NF/MY. The eight AOIs are presented below in Table 1 and displayed in Figure 1.

Table 1. Supplemental RFI NF/MY Areas of Investigation

Area/Unit	Description
MY1	
AOC 33	Tank 314 Basin
AOC 34	Tank 315 Basin
PAOC 42	Tank 317 Basin
PAOC 86	Hydrotreater
MY2	
AOC 10	Stained Soil and Gravel in Area of IAF Tank
AOC 48	Isomax Process Plant
AOC 49	#3 Rheniformer
PAOC 84	PA Plant
SWMU 44	Unnamed Main Yard Pond
MY3	
AOC 1	Potential Discharge From Tank 1
AOC 18	Potential Discharge From Tank 2
AOC 19	Main Yard Pipeway
AOC 19-LNAPL	Main Yard Pipeway
PAOC 8	MY Outside Manifold
NF2	
AOC 9B	Contamination at Well NF-11
PAOC 22	Tank 312, 313, 318 Pump Manifold
PAOC 36	Tank 308 Basin
PAOC 37	Tank 309 Basin
SWMU 22	TEL Burial East of Tank 329
SWMU 43	Mud Flats
SWMU 53	Potential Discharge Into Tank 312 Basin
NF2-LNAPL	LNAPL at Area NF2
NF3A	
AOC 6A	Oily Petroleum Material at B-26, B-34
PAOC 6	Gasoline Blender
PAOC 10	Boars Nest
SWMU 19	TEL Burial West of Tank 326
SWMU 35	No. 4 Separator
NF3-LNAPL	LNAPL at Area NF3
NF3B	
AOC 9A	Contamination at Well NF-10
PAOC 73	Tank 75D-1 Basin
SWMU 20	TEL Burial East of Tank 302
SWMU 43	Mud Flats

Table 1. Supplemental RFI NF/MY Areas of Investigation

Area/Unit	Description
NF5	
AOC 23	Tank 327 Basin
AOC 41	Tank 300 Basin
SWMU 17	TEL Burial East of Tank 301
SWMU 18	TEL Burial West of Tank 301
SWMU 24	TEL Weathering Area East of Tank 9209, South of ETP
SWMU 31	Effluent Treatment Plant
SWMU 41	Drying Area
NF6	
AOC 8	Oily and Tarry Material at B-27, B-28
AOC 8/NF6-LNAPL	LNAPL at Area AOC8/NF6
AOC 15	Oil Release at Buckeye Pipeline Manifold
PAOC 76	#1 & 2 Crude Unit
SWMU 6	TEL Burial West of Tank 306
SWMU 7	TEL Burial – 2 Burials Southeast of Tank 305
SWMU 16	TEL Burial East of Tank 306
SWMU 40	Old Pond
NF5-LNAPL	LNAPL at Area NF5

TEL = Tetra-ethyl lead.

LNAPL = Light, non-aqueous phase liquid.

The AOIs in the NF/MY were defined using CEMC's ongoing data visualization activities and included existing AOCs, SWMUs, and PAOCs. This technical approach was accepted by the EPA in a letter dated November 2, 2006 with an understanding that each COC would be identified and delineated horizontally and vertically at each AOI. Chevron created an extensive three-dimensional visualization model utilizing historical data to identify the location of any data gaps both horizontally and vertically across the NF/MY.

After completing this analysis, CEMC determined that three of the eight AOIs were adequately characterized and delineated. Accordingly, the SRFI field investigation focused on the following five AOIs:

- North Field 2 (NF2)
- North Field 3A (NF3A)
- North Field 3B (NF3B)
- North Field 5 (NF5)
- North Field 6 (NF6)

In October 2006, an SRFI DWP (Chevron, 2006b) to investigate these five AOIs was submitted to the EPA and NJDEP prior to commencement of field activities. The NF/MY SRFI DWP utilized a decision-based approach to conduct additional soil and

groundwater investigations of AOIs in the NF/MY. The SRFI of the NF/MY began in October 2006 and was completed in March 2007.

In addition, three AOIs were developed in the East Yard (EY), also based on three-dimensional visualization modeling (please see Table 2). Each EY AOI is presented on a site location map in Figure 2.

Table 2. East Yard – Areas of Investigation

Area/Unit	Description
AOI 1	
AOC 16	Oily Water Sewer System
AOC 27	Tank 777 Pipeway
AOC 35	Tank 771 Basin
AOC 37	East Yard Gasoline Filters
AOI 2	
AOC 14	GWQAP Oily Fill Area III
AOC 16	Oily Water Sewer System
AOC 26	East Yard Bunker Slab
SWMU 26	TEL Weathering Area (S of EY Basin)
SWMU 36	Oil/Water Separator Near East Yard Basin
AOI 3	
AOC 6B	Oily Petroleum Material at B-29, B-30, B-31
AOC 16	Oily Water Sewer System
AOC 29	5 Berth
AOC 45	Tank Basin 748
AOC 46	Tank Basin 749, 780

In addition, the following areas were investigated in the EY during the SRFI.

- AOC 13
- AOC 31
- AOC 38
- AOC 39
- Perimeter well MW-6
- SWMU 8
- SWMU 36

These additional areas were investigated based on NJDEP comments on the original RFI Report and/or data visualization modeling of the area indicating data gaps.

In December 2006, an SRFI DWP (Chevron, 2006c) to investigate the AOIs in the EY was submitted to the EPA and NJDEP prior to commencement of field activities. The EY SRFI DWP also utilized a decision-based approach to conduct soil and groundwater

investigations of AOIs in the EY. The SRFI of the EY began in November 2006 and was completed in February 2007.

On May 10, 2007, CEMC made a presentation of the preliminary SRFI findings to the EPA and NJDEP. At this meeting, NJDEP requested that the RFI Evaluation Criteria be updated to include the latest NJDEP groundwater standards. CEMC agreed that all SRFI findings would be presented relative to the latest NJDEP soil and groundwater criteria (see Section 2).

1.1 Stabilization Measures Status Report

In January 2007, the 2005 Stabilization Measures Status Report was submitted by CEMC to EPA and NJDEP for formal review. This report summarizes the LNAPL delineation and recovery activities that Chevron completed at the Perth Amboy Refinery between January 1, 2005 and December 31, 2005.

To date, Chevron has identified 17 areas where LNAPL has been observed or is present at the Refinery. The LNAPL plumes represent areas where LNAPL has been observed in one or more temporary piezometers or permanent monitoring wells.

Much of the LNAPL at the Chevron Refinery is weathered, is found at relatively shallow depths (less than 10 ft. bgs), and, irrespective of aerial extent, is generally present with apparent thicknesses of less than one foot. Apparent thickness is the thickness of LNAPL measured in a well; not the actual LNAPL thickness in the adjacent formation. Based on the age and small apparent thicknesses, most of the LNAPL present appears to be relatively immobile in the subsurface.

Based on analytical fingerprinting performed at 16 of the 17 areas, the LNAPL encountered at the Refinery is typically composed of various mixtures of weathered crude, refining residuals, weathered diesel, and weathered gasoline. The properties of the LNAPL vary greatly, with specific gravity values for various samples of LNAPL ranging from 0.797 to 0.984, and kinematic viscosity values ranging from 1.1 to 20,349 centistokes.

Although LNAPL properties and occurrences vary, the distribution of LNAPL within the fill is similar within all of the LNAPL areas. LNAPL is typically found within the more permeable lenses and layers of flyash and catalyst beads. These more permeable layers and lenses were placed during various periods of filling and, based on boring logs, are not continuous. Many of the lenses are located below the water table.

The releases of LNAPL are believed to be fairly old, based on the site history and because most of the LNAPL is weathered. With a few exceptions, the accumulations of LNAPL in wells tend to be small, usually less than 0.1 feet. When the residual saturation of LNAPL is high enough (usually 20% of pore space or greater, based on the literature), the lower viscosity LNAPL will drain to a well. However, the lenses are often depleted rapidly. A typical example is the SWMU 40 LNAPL Area. In 1995, based on the

accumulation of LNAPL in temporary wells, Chevron began excavation for a recovery well and found the fill in the area to consist of predominantly clay with isolated lenses of catalyst beads. Although the excavation was completed to a depth of 12 feet, no LNAPL entered the excavation.

Although LNAPL will occasionally drain to a well, as described above, the LNAPL areas are not believed to be moving laterally because:

- The LNAPL releases are old and the LNAPL has had time to stabilize;
- LNAPL is not found in continuous “pools” but in discontinuous lenses and layers of flyash and catalyst beads surrounded by lower permeability material (i.e., clay);
- Many of the lenses and layers are below the water table;
- The accumulation of LNAPL in monitoring wells is typically small; therefore the actual LNAPL “thickness” in the formation is small;
- Much of the LNAPL has a high viscosity in the range of motor oil or greater; and
- Groundwater seepage velocity across the site is very low.

1.2 Solid Waste Management Area/Area of Concern Assessment Reports

On February 26 2007, the SARs were submitted by CEMC to the EPA and NJDEP for formal review. These 13 new AOCs (former PAOCs listed below) were identified and recommended for addition to Chevron’s HSWA Permit (USEPA, 1994) for further investigation during the SRFI.

- AOC 37 – East Yard Gasoline Filters (PAOC 17)
- AOC 38 – Barge Loading Manifold and G180/181 Naphtha Pumps (PAOCs 18 and 19)
- AOC 39 – East Yard Pump House and PRC Loading Rack (PAOCs 24 and 25)
- AOC 40 – Tank Basin 22 (PAOC 30)
- AOC 41 – Tank Basin 300 (PAOC 32)
- AOC 42 – Tank Basin 310 (PAOC 38)
- AOC 43 – Tank Basin 311 (PAOC 39)
- AOC 44 – Tank Basin 313 (PAOC 40)
- AOC 45 – Tank Basin 748 (PAOC 53)
- AOC 46 – Tank Basins 749 and 780 (PAOC 54)
- AOC 47 – No. 4 Crude Unit (PAOC 78)

- AOC 48 – Isomax Process Plant (PAOC 81)
- AOC 49 – #3 Rheniformer (PAOC 83)

EPA correspondence dated February 13, 2004 initially identified these new AOCs pursuant to Module III, Section C.2 of the Refinery HSWA permit (USEPA, 1994). No regulatory comments have been received to date on the SARs.

1.3 Potential Areas of Concern Report

On June 18, 2007, the PAOC Report (Chevron, 2007b) was submitted by CEMC to the EPA and NJDEP for formal review. The primary goal of Chevron's PAOC effort was to identify and assess units of environmental concern (as described by NJAC 7:26E), which were not already identified in Chevron's HSWA Permit (USEPA, 1994). The PAOC Report describes the investigation of 45 PAOCs. Seven of these PAOCs overlapped with existing AOCs/SWMUs, and were therefore investigated during the RFI. Fifteen PAOCs were recommended for no further investigation (NFI). Another 15 PAOCs were recommended for addition to the HSWA Permit for further investigation as new AOCs during the SRFI. These 15 PAOCs were submitted to the EPA and NJDEP in the SARs (Chevron, 2007a) in February 2007. Finally, eight PAOC investigations are still ongoing and are to be completed in 2008. No regulatory comments have been received to date on the PAOC Report. It is anticipated that a Supplemental PAOC Report will be submitted to EPA and NJDEP for review in 2008.

2. SRFI Evaluation Criteria

The SRFI Evaluation Criteria utilized by Chevron for both groundwater and soil during the SRFI are presented in Table 3 and Table 4 respectively. In addition to the values themselves, the table includes the source from which each value was obtained. Chevron utilized NJDEP Class IIA Groundwater Quality Criteria (GWQC) (NJDEP, 2005a) when assessing groundwater. Chevron utilized the NJDEP Soil Cleanup Criteria (SCC) (NJDEP, 1999) when assessing soils, using the most stringent of the NJDEP Impact to Groundwater Soil Cleanup Criteria (IGWSCC), Non-Residential Direct Contact Soil Cleanup Criteria (NRDCSCC), or Residential Direct Contact Soil Cleanup Criteria (RDCSCC) issued in 1999, or risk-based concentrations and/or preliminary remediation goals developed in EPA Region 3 or EPA Region 9. In some cases, if no standard existed, Chevron utilized default values for total organic contaminants (TOC) or total volatile organic contaminants (TVOC).

The SRFI Evaluation Criteria were utilized by Chevron as a decision-making tool to determine the horizontal and vertical extent of contamination during the RFI and SRFI. In the case of soils, Chevron utilized the NJDEP NRDCSCC as an action level for benzene (13 mg/kg) and lead (600 mg/kg) to delineate the extent of soil contamination. The data obtained from the RFI and SRFI will allow Chevron to develop cleanup goals during the Corrective Measures Study (CMS) pursuant to the HSWA Permit.

The SRFI Evaluation Criteria are not site-specific cleanup criteria for environmental media on-site. Site-specific cleanup criteria will be developed during the CMS. These site-specific cleanup levels will be submitted to EPA and NJDEP for approval. The approved cleanup goals will then be used to evaluate potential remedial measures during the CMS.

It should be noted that Chevron applied for Alternative Remedial Criteria (ARC) for several analytes applicable to soils in a letter dated February 12, 2003. NJDEP and EPA approved the following site-specific changes to the NJDEP SCC in a letter from NJDEP to Chevron, dated April 3, 2003.

- Beryllium: RDCSCC 16 mg/kg, NRDCSCC 200 mg/kg;
- Thallium: RDCSCC 5.5 mg/kg, NRDCSCC 72 mg/kg; and
- Chrysene: RDCSCC 62 mg/kg, NRDCSCC 230 mg/kg.

It should be noted that in the absence of NJDEP approved Class IIA GWQC for any analyte in groundwater, Chevron utilized NJDEP Interim Specific or Interim Generic Criteria if available.

Table 3. SRFI Groundwater Evaluation Criteria

Analyte (µg/L)	NJDEP Class IIA	Laboratory PQL	Evaluation Criteria	Source
Aluminum	200	30	200	NJDEP Class IIA
Antimony	6	3	6	NJDEP Class IIA
Arsenic	0.02	3	3	NJDEP Class IIA
Barium	2,000	200	2,000	NJDEP Class IIA
Beryllium	1	1	1	NJDEP Class IIA
Cadmium	4	0.5	4	NJDEP Class IIA
Calcium	NA	NA	NA	NA
Chromium	70	1	70	NJDEP Class IIA
Cobalt	NA	NA	5	Interim Generic Criteria*
Copper	1,300	4	1,300	NJDEP Class IIA
Iron	300	20	300	NJDEP Class IIA
Lead	5	5	5	NJDEP Class IIA
Magnesium	NA	NA	NA	NA
Manganese	50	0.4	50	NJDEP Class IIA
Mercury	2	0.05	2	NJDEP Class IIA
Nickel	100	4	100	NJDEP Class IIA
Potassium	NA	NA	NA	NA
Selenium	40	4	40	NJDEP Class IIA
Silver	40	1	40	NJDEP Class IIA
Sodium	50,000	400	50,000	NJDEP Class IIA
Thallium	0.5	2	2	NJDEP Class IIA
Vanadium**	60	1	60	NJDEP Class IIA
Zinc	2,000	10	2,000	NJDEP Class IIA
1,1,1-Trichloroethane	30	1	30	NJDEP Class IIA
1,1,2,2-Tetrachloroethane	1	1	1	NJDEP Class IIA
1,1,2-Trichloroethane	3	2	3	NJDEP Class IIA
1,1'-Biphenyl	400	10	400	NJDEP Class IIA
1,1-Dichloroethane	50	1	50	NJDEP Class IIA
1,1-Dichloroethene	1	1	1	NJDEP Class IIA
1,2,4-Trichlorobenzene	9	1	9	NJDEP Class IIA
1,2-Dibromo-3-chloropropane	0.02	0.02	0.02	NJDEP Class IIA
1,2-Dibromoethane	0.0004	0.03	0.03	NJDEP Class IIA
1,2-Dichlorobenzene	600	5	600	NJDEP Class IIA
1,2-Dichloroethane	0.3	2	2	NJDEP Class IIA
1,2-Dichloropropane	0.5	1	1	NJDEP Class IIA
1,3-Dichlorobenzene	600	5	600	NJDEP Class IIA
cis-1,3-Dichloropropene	0.4	1	1	NJDEP Class IIA
trans-1,3-Dichloropropene	0.4	1	1	NJDEP Class IIA
1,4-Dichlorobenzene	75	5	75	NJDEP Class IIA

Table 3. SRFI Groundwater Evaluation Criteria

Analyte (µg/L)	NJDEP Class IIA	Laboratory PQL	Evaluation Criteria	Source
2,2'-oxybis (1-chloropropane)	300	10	300	NJDEP Class IIA
2,4,5-Trichlorophenol	700	10	700	NJDEP Class IIA
2,4,6-Trichlorophenol	1	20	20	NJDEP Class IIA
2,4-Dichlorophenol	20	10	20	NJDEP Class IIA
2,4-Dimethylphenol	100	20	100	NJDEP Class IIA
2,4-Dinitrophenol	10	40	40	NJDEP Class IIA
2,4-Dinitrotoluene/ 2,6-Dinitrotoluene	0.05	10	10	NJDEP Class IIA
2-Butanone	300	2	300	NJDEP Class IIA
2-Chloronaphthalene	600	10	600	NJDEP Class IIA
2-Chlorophenol	40	20	40	NJDEP Class IIA
2-Hexanone	N/A	N/A	100	Interim Generic Criteria*
2-Methylnaphthalene	N/A	N/A	100	Interim Generic Criteria*
2-Methylphenol	N/A	N/A	100	Interim Generic Criteria*
2-Nitroaniline	N/A	N/A	100	Interim Generic Criteria*
2-Nitrophenol	N/A	N/A	100	Interim Generic Criteria*
3,3'-Dichlorobenzidine	0.08	30	30	NJDEP Class IIA
3-Nitroaniline	N/A	N/A	100	Interim Generic Criteria*
4-Bromophenylphenyl ether	N/A	N/A	100	Interim Generic Criteria*
4-Chloroaniline	30	10	30	NJDEP Class IIA
4-Chloro-3-methylphenol	N/A	N/A	100	Interim Generic Criteria*
4-Chlorophenylphenyl ether	N/A	N/A	100	Interim Generic Criteria*
4,6-Dinitro-2-methylphenol	N/A	N/A	100	Interim Generic Criteria*
4-Methyl-2-pentanone	N/A	N/A	100	Interim Generic Criteria*
4-Methylphenol	N/A	N/A	100	Interim Generic Criteria*
4-Nitroaniline	NA	NA	100	Interim Generic Criteria*
4-Nitrophenol	NA	NA	100	Interim Generic Criteria*

Table 3. SRFI Groundwater Evaluation Criteria

Analyte (µg/L)	NJDEP Class IIA	Laboratory PQL	Evaluation Criteria	Source
Acenaphthene	400	10	400	NJDEP Class IIA
Acenaphthylene	NA	NA	100	Interim Generic Criteria*
Acetone	6,000	10	6,000	NJDEP Class IIA
Acetophenone	700	10	700	NJDEP Class IIA
Anthracene	2,000	10	2,000	NJDEP Class IIA
Atrazine	3	0.1	3	NJDEP Class IIA
Benzaldehyde	NA	NA	100	Interim Generic Criteria*
Benzene	0.2	1	1	NJDEP Class IIA
Benzo(a)anthracene	0.05	0.1	0.1	NJDEP Class IIA
Benzo(a)pyrene	0.005	0.1	0.1	NJDEP Class IIA
Benzo(b)fluoranthene	0.05	0.2	0.2	NJDEP Class IIA
Benzo(ghi)perylene	NA	NA	100	Interim Generic Criteria*
Benzo(k)fluoranthene	0.5	0.3	0.5	NJDEP Class IIA
Bis(2-chloroethoxy) methane	NA	NA	100	Interim Generic Criteria*
Bis(2-chloroethyl)ether	0.03	7	7	NJDEP Class IIA
Bis(2-ethylhexyl)phthalate	2	3	3	NJDEP Class IIA
Bromodichloromethane	0.6	1	1	NJDEP Class IIA
Bromoform	4	0.8	4	NJDEP Class IIA
Bromomethane	10	1	10	NJDEP Class IIA
Butylbenzylphthalate	100	1	100	NJDEP Class IIA
Caprolactum	NA	NA	100	Interim Generic Criteria*
Carbazole	NA	NA	100	Interim Generic Criteria*
Carbon disulfide	700	1	700	NJDEP Class IIA
Carbon tetrachloride	0.4	1	1	NJDEP Class IIA
Chlorobenzene	50	1	50	NJDEP Class IIA
Chloroethane	NA	NA	100	Interim Generic Criteria*
Chloromethane	NA	NA	100	Interim Generic Criteria*
Chloroform	70	1	70	NJDEP Class IIA
Chrysene	5	0.2	5	NJDEP Class IIA
Cyclohexane	NA	NA	100	Interim Generic Criteria*
cis-1,2-Dichloroethene	70	1	70	NJDEP Class IIA
Dibenz(a,h)anthracene	0.005	0.3	0.3	NJDEP Class IIA

Table 3. SRFI Groundwater Evaluation Criteria

Analyte (µg/L)	NJDEP Class IIA	Laboratory PQL	Evaluation Criteria	Source
Dibenzofuran	NA	NA	100	Interim Generic Criteria*
Dibromochloromethane	0.4	1	1	NJDEP Class IIA
Dichlorodifluoromethane	1,000	2	1,000	NJDEP Class IIA
Diethylphthalate	6,000	1	6,000	NJDEP Class IIA
Dimethylphthalate	NA	NA	100	Interim Generic Criteria*
Di-n-butylphthalate	700	1	700	NJDEP Class IIA
Di-n-octylphthalate	100	10	100	NJDEP Class IIA
Ethylbenzene	700	2	700	NJDEP Class IIA
Fluoranthene	300	10	300	NJDEP Class IIA
Fluorene	300	1	300	NJDEP Class IIA
Freon113	NA	NA	100	Interim Generic Criteria*
Hexachlorobenzene	0.02	0.02	0.02	NJDEP Class IIA
Hexachlorobutadiene	0.4	1	1	NJDEP Class IIA
Hexachlorocyclopentadiene	40	0.5	40	NJDEP Class IIA
Hexachloroethane	2	7	7	NJDEP Class IIA
Indeno(1,2,3-cd)pyrene	0.05	0.2	0.2	NJDEP Class IIA
Isophorone	40	10	40	NJDEP Class IIA
Isopropylbenzene	700	1	700	NJDEP Class IIA
Methyl acetate	7,000	0.5	7,000	NJDEP Class IIA
Methylcyclohexane	NA	NA	100	Interim Generic Criteria*
Methyl t-butyl ether	70	1	70	NJDEP Class IIA
Methylene chloride	3	1	3	NJDEP Class IIA
Naphthalene	300	2	300	NJDEP Class IIA
Nitrobenzene	4	6	6	NJDEP Class IIA
N-Nitroso-di-n-propylamine	0.005	10	10	NJDEP Class IIA
N-Nitrosodiphenylamine	7	10	10	NJDEP Class IIA
Phenanthrene	NA	NA	100	Interim Generic Criteria*
Pentachlorophenol	0.3	0.1	0.3	NJDEP Class IIA
Phenol	2,000	10	2,000	NJDEP Class IIA
Pyrene	200	0.1	200	NJDEP Class IIA
Styrene	100	2	100	NJDEP Class IIA
Tetrachloroethene	0.4	1	1	NJDEP Class IIA
Toluene	1,000	1	1,000	NJDEP Class IIA
trans-1,2-Dichloroethene	100	1	100	NJDEP Class IIA
Trichloroethene	1	1	1	NJDEP Class IIA

Table 3. SRFI Groundwater Evaluation Criteria

Analyte (µg/L)	NJDEP Class IIA	Laboratory PQL	Evaluation Criteria	Source
Trichlorofluoromethane	2,000	1	2,000	NJDEP Class IIA
Vinyl Chloride	0.08	1	1	NJDEP Class IIA
Xylenes (Total)	1,000	2	1,000	NJDEP Class IIA

PQL - Practical Quantitation Level

NA - Criterion Not Available

*Interim Generic Criteria of 5 µg/L for carcinogens and 100 µg/L for non-carcinogens assigned based on literature review.

**NJDEP Class IIA GWQC for vanadium pentoxide is used.

Table 4. RFI Soil Evaluation Criteria

Analyte (mg/kg)	CAS	NJDEP RDCSCC	NJDEP NRDSCC	NJDEP IGWSCC	Evaluation Criteria	Source
1,1'-Biphenyl	92-52-4	NA	NA	NA	350	Region 9 PRG (residential)
2,2'-Oxybis(1-chloropropane)	39638-32-9 108-60-1	2,300	10,000	10	10	NJDEP SCC
2,4,5-Trichlorophenol	95-95-4	5,600	10,000	50	50	NJDEP SCC
2,4,6-Trichlorophenol	88-06-2	62	270	10	10	NJDEP SCC
2,4-Dichlorophenol	120-83-2	170	3,100	10	10	NJDEP SCC
2,4-Dimethylphenol	105-67-9	1,100	10,000	10	10	NJDEP SCC
2,4-Dinitrophenol	51-28-5	110	2,100	10	10	NJDEP SCC
2,4-Dinitrotoluene	121-14-2	1	4	10	1	NJDEP SCC
2,6-Dinitrotoluene	606-20-2	1	4	10	1	NJDEP SCC
2-Chloronaphthalene	91-58-7	NA	NA	NA	1,000	Reg. 9 PRG is 49,000 so use TVOC default instead
2-Chlorophenol	95-57-8	280	5,200	10	10	NJDEP SCC
2-Methylnaphthalene	91-57-6	NA	NA	NA	10,000	No standards use TOC default instead
2-Methylphenol	95-48-7	2,800	10,000	NA	2,800	NJDEP SCC
2-Nitroaniline	88-74-4	NA	NA	NA	1.7	Region 9 PRG (residential)
2-Nitrophenol	88-75-5	NA	NA	NA	10,000	No standards use TOC default instead
3,3'-Dichlorobenzidine	91-94-1	2	6	100	2	NJDEP SCC
3-Nitroaniline	99-09-2	NA	NA	NA	23	Region 3 RBC for Residential DC
4,6-Dinitro-2-methylphenol	534-52-1	NA	NA	NA	7.8	Region 3 RBC for Residential DC
4-Bromophenyl-phenylether	101-55-3	NA	NA	NA	1,000	No standards use TVOC default
4-Chloro-3-methylphenol	59-50-7	10,000	10,000	100	100	NJDEP SCC
4-Chloroaniline	106-47-8	230	4,200	NA	230	NJDEP SCC
4-Chlorophenyl-phenylether	7005-72-3	NA	NA	NA	1,000	No standards use TVOC default
4-Methylphenol	106-44-5	2,800	10,000	NA	2,800	NJDEP SCC
4-Nitroaniline	100-01-6	NA	NA	NA	32	Region 3 RBC for Residential DC

Table 4. RFI Soil Evaluation Criteria

Analyte (mg/kg)	CAS	NJDEP RDCSCC	NJDEP NRDSCC	NJDEP IGWSCC	Evaluation Criteria	Source
4-Nitrophenol	100-02-7	NA	NA	NA	1.7	Region 3 RBC for GW migration, DAF=20
Acenaphthene	83-32-9	3,400	10,000	100	100	NJDEP SCC
Acenaphthylene	208-96-8	NA	NA	NA	10,000	No standards, use TOC default
Acetophenone	98-86-2	NA	NA	NA	0.00022	Region 3 RBC for GW migration, DAF=20
Anthracene	120-12-7	10,000	10,000	100	100	NJDEP SCC
Atrazine	1912-24-9	NA	NA	NA	2.2	Region 9 PRG (residential)
Benzaldehyde	100-52-7	NA	NA	NA	6,100	Region 9 PRG (residential)
Benzo(a)anthracene	56-55-3	0.9	4	500	0.9	NJDEP SCC
Benzo(a)pyrene	50-32-8	0.66	0.66	100	0.66	NJDEP SCC
Benzo(b)fluoranthene	205-99-2	0.9	4	50	0.9	NJDEP SCC
Benzo(g,h,i)perylene	191-24-2	NA	NA	NA	10,000	No standards, use TOC default
Benzo(k)fluoranthene	207-08-9	0.9	4	500	0.9	NJDEP SCC
bis(2-Chloroethoxy)methane	111-91-1	NA	NA	NA	10,000	No standards, use TOC default
bis(2-Chloroethyl)ether	111-44-4	0.66	3	10	0.66	NJDEP SCC
bis(2-Ethylhexyl)phthalate	117-81-7	49	210	100	49	NJDEP SCC
Butylbenzylphthalate	85-68-7	1,100	10,000	100	100	NJDEP SCC
Caprolactam	105-60-2	NA	NA	NA	10,000	Region 9 PRG is 31,000, use TOC default
Carbazole	86-74-8	NA	NA	NA	0.6	Region 9 PRG Migration to GW, DAF=20
Chrysene	218-01-9	62	230	NA	62	Site Specific Standard
Dibenz(a,h)anthracene	53-70-3	0.66	0.66	100	0.66	NJDEP SCC
Dibenzofuran	132-64-9	NA	NA	NA	290	Region 9 PRG (residential)
Diethylphthalate	84-66-2	10,000	10,000	50	50	NJDEP SCC

Table 4. RFI Soil Evaluation Criteria

Analyte (mg/kg)	CAS	NJDEP RDCSCC	NJDEP NRDSCC	NJDEP IGWSCC	Evaluation Criteria	Source
Dimethylphthalate	131-11-3	10,000	10,000	50	50	NJDEP SCC
Di-n-butylphthalate	84-74-2	5,700	10,000	100	100	NJDEP SCC
Di-n-octylphthalate	117-84-0	1,100	10,000	100	100	NJDEP SCC
Fluoranthene	206-44-0	2,300	10,000	100	100	NJDEP SCC
Fluorene	86-73-7	2,300	10,000	100	100	NJDEP SCC
Hexachlorobenzene	118-74-1	0.66	2	100	0.66	NJDEP SCC
Hexachlorobutadiene	87-68-3	1	21	100	1	NJDEP SCC
Hexachlorocyclopentadiene	77-47-4	400	7,300	100	100	NJDEP SCC
Hexachloroethane	67-72-1	6	100	100	6	NJDEP SCC
Indeno(1,2,3-cd)pyrene	193-39-5	0.9	4	500	0.9	NJDEP SCC
Isophorone	78-59-1	1,100	10,000	50	50	NJDEP SCC
Naphthalene	91-20-3	230	4,200	100	100	NJDEP SCC
Nitrobenzene	98-95-3	28	520	10	10	NJDEP SCC
N-Nitroso-di-n-propylamine	86-30-6	0.66	0.66	10	0.66	NJDEP SCC
N-Nitrosodiphenylamine	621-64-7	140	600	100	100	NJDEP SCC
Pentachlorophenol	87-86-5	6	24	100	6	NJDEP SCC
Phenanthrene	85-01-8	NA	NA	NA	10,000	No criteria available, use default for TOC
Phenol	108-95-2	10,000	10,000	50	50	NJDEP SCC
Pyrene	129-00-0	1,700	10,000	100	100	NJDEP SCC
1,1,1-Trichloroethane	71-55-6	210	1000	50	50	NJDEP SCC
1,1,2,2-Tetrachloroethane	79-34-5	34	70	1	1	NJDEP SCC
1,1,2-Trichloroethane	79-00-5	22	420	1	1	NJDEP SCC
1,1-Dichloroethane	75-34-3	570	1,000	10	10	NJDEP SCC
1,1-Dichloroethene	75-35-4	8	150	10	8	NJDEP SCC
1,2,4-Trichlorobenzene	120-82-1	68	1,200	100	68	NJDEP SCC

Table 4. RFI Soil Evaluation Criteria

Analyte (mg/kg)	CAS	NJDEP RDCSCC	NJDEP NRDSCC	NJDEP IGWSCC	Evaluation Criteria	Source
1,2-Dichloroethane	107-06-2	6	24	1	1	NJDEP SCC
1,2-Dichloropropane	78-87-5	10	43	NA	10	NJDEP SCC
2-Hexanone	591-78-6	NA	NA	NA	3,100	Reg 3 RBC for Residential DC
Acetone	67-64-1	1,000	1,000	100	100	NJDEP SCC
Benzene	71-43-2	3	13	1	1	NJDEP SCC
Isopropylbenzene	98-82-8	NA	NA	NA	570	aka cumene; Region 9 RBC (residential)
Bromodichloromethane	75-27-4	11	46	1	1	NJDEP SCC
Bromoform	75-25-2	86	370	1	1	NJDEP SCC
Carbon disulfide	75-15-0	NA	NA	NA	32	Region 9 PRG Migration to GW, DAF=20
Carbon tetrachloride	56-23-5	2	4	1	1	NJDEP SCC
Chlorobenzene	108-90-7	37	680	1	1	NJDEP SCC
Chloroethane	75-00-3	NA	NA	NA	3	Region 9 PRG (residential)
Chloroform	67-66-3	19	28	1	1	NJDEP SCC
cis-1,2-Dichloroethene	156-59-2	79	1,000	1	1	NJDEP SCC
cis-1,3-Dichloropropene	10061-01-5	4	5	1	1	NJDEP SCC
Cyclohexane	110-82-7	NA	NA	NA	140	Region 9 PRG (residential)
1,2-Dibromo-3-chloropropane	96-12-8	NA	NA	NA	0.45	Region 9 PRG (residential)
Dibromochloromethane	124-48-1	110	1,000	1	1	NJDEP SCC
Dichlorodifluoromethane	75-71-8	NA	NA	NA	94	Region 9 PRG (residential)
1,2-Dibromoethane	106-93-4	NA	NA	NA	0.0069	Region 9 PRG (residential)
trans-1,2-Dichloroethene	156-60-5	1,000	1,000	50	50	NJDEP SCC
Ethylbenzene	100-41-4	1,000	1,000	100	100	NJDEP SCC
Freon 113	76-13-1	NA	NA	NA	1,000	
1,3-Dichlorobenzene	541-73-1	5,100	10,000	100	100	NJDEP SCC

Table 4. RFI Soil Evaluation Criteria

Analyte (mg/kg)	CAS	NJDEP RDCSCC	NJDEP NRDSCC	NJDEP IGWSCC	Evaluation Criteria	Source
Methyl acetate	70-20-9	NA	NA	NA	1,000	Region 9 RBC is 22,000, use TVOC default
Bromomethane	74-83-9	79	1,000	1	1	NJDEP SCC
Chloromethane	74-87-3	520	1,000	10	10	NJDEP SCC
2-Butanone	78-93-3	1,000	1,000	50	50	NJDEP SCC
4-Methyl-2-pentanone	108-10-1	1,000	1,000	50	50	NJDEP SCC
Methyl t-butyl ether	1634-04-4	NA	NA	NA	62	Region 9 RBC (residential)
Methylcyclohexane	108-87-2	NA	NA	NA	1,000	Region 9 RBC is 2,600, use TVOC default
Methylene chloride	75-09-2	49	210	1	1	NJDEP SCC
1,2-Dichlorobenzene	95-50-1	5,100	10,000	50	50	NJDEP SCC
1,4-Dichlorobenzene	106-46-7	570	10,000	100	100	NJDEP SCC
Styrene	100-42-5	23	97	100	23	NJDEP SCC
Tetrachloroethene	127-18-4	4	6	1	1	NJDEP SCC
Toluene	108-88-3	1,000	1,000	500	500	NJDEP SCC
trans-1,3-Dichloropropene	10061-02-6	4	5	1	1	NJDEP SCC
Trichloroethene	79-01-6	23	54	1	1	NJDEP SCC
Trichlorofluoromethane	75-69-4	NA	NA	NA	390	Region 9 PRG (residential)
Vinyl chloride	75-01-4	2	7	10	2	NJDEP SCC
Xylene (Total)	1330-20-7	410	1,000	67	67	NJDEP SCC
Aluminum	7429-90-5	NA	NA	NA	76,000	Region 9 PRG (residential)
Antimony	7440-36-0	14	340	NA	14	NJDEP SCC
Arsenic	7440-38-2	20	20	NA	20	NJDEP SCC
Barium	7440-39-3	700	47,000	NA	700	NJDEP SCC
Beryllium	7440-41-7	16	200	NA	16	Site Specific Standard
Cadmium	7440-43-9	39	100	NA	39	NJDEP SCC

Table 4. RFI Soil Evaluation Criteria

Analyte (mg/kg)	CAS	NJDEP RDCSCC	NJDEP NRDSCC	NJDEP IGWSCC	Evaluation Criteria	Source
Calcium	7440-70-2	NA	NA	NA	NA	
Chromium	7440-47-3	120,000	NA	NA	120,000	NJDEP SCC
Cobalt	7440-48-4	NA	NA	NA	900	Region 9 PRG (residential)
Copper	7440-50-8	600	600	NA	600	NJDEP SCC
Iron	7439-89-6	NA	NA	NA	23,000	Region 9 PRG (residential)
Lead	7439-92-1	400	600	NA	400	NJDEP SCC
Total Organic Lead		NA	NA	NA	2	Site Specific Standard
Magnesium	7439-95-4	NA	NA	NA	NA	
Manganese	7439-96-5	NA	NA	NA	1,800	Region 9 PRG (residential)
Mercury	7439-97-6	14	270	NA	14	NJDEP SCC
Nickel	7440-02-0	250	2,400	NA	250	NJDEP SCC
Potassium	7440-09-7	NA	NA	NA	NA	
Selenium	7782-49-2	63	3,100	NA	63	NJDEP SCC
Silver	7440-22-4	110	4,100	NA	110	NJDEP SCC
Sodium	7440-23-5	NA	NA	NA	NA	
Thallium	7440-28-0	5.5	72	NA	5.5	Site Specific Standard
Vanadium	7440-62-2	370	7,100	NA	370	NJDEP SCC
Zinc	7440-66-6	1,500	1,500	NA	1,500	NJDEP SCC

CAS = Chemical Abstracts Service Number

TOC = Total Organic Contaminant

TVOC = Total Volatile Organic Contaminant

PRG = Preliminary Remediation Goal

RBC = Risk-Based Concentration

DAF = Dilution Attenuation Factor

NA = Criterion Not Available

3. SRFI Field Investigation Summary

In their January 21, 2005 RFI Report comment letter (USEPA, 2005), EPA and NJDEP identified various areas where additional investigation might be necessary. As previously discussed, CEMC reviewed the Agencies' comments, evaluated the existing database, and developed supplemental investigation work plans to address potential data gaps as part of the SRFI. From October 2006 through March 2007, the following activities were completed in the NF/MY and EY during the SRFI field investigation:

- 136 soil borings;
- 309 soil samples collected and analyzed;
- 18 membrane interface probe (MIP) survey points;
- 13 permanent shallow groundwater monitoring wells installed;
- 10 permanent dual cased ("deep") groundwater monitoring wells installed;
- 13 temporary shallow groundwater monitoring wells installed;
- 36 SRFI groundwater samples collected and analyzed; and
- Visualization modeling of historical and SRFI data.

The investigative methodology employed in the SRFI is discussed in Section 4. The findings of the SRFI are presented in Section 5.

4. SRFI Methodology

4.1 Soil Investigation

4.1.1 Soil Borings

During the SRFI, a total of 136 soil borings were installed across the MY/NF, and EY using the decision-based sampling and analysis strategy, as detailed in their respective SRFI DWPs (Chevron, 2006b and 2006c). All field sampling activities were conducted in accordance with the NJDEP Field Sampling Procedures Manual (2005), Addendum Full RCRA Facility Investigation Work Plan (Chevron, 2002), and the Refinery Wide General Sampling and Analysis/Quality Assurance Project Plan (Chevron, 1994). SRFI soil sample locations are shown on Figure 3.

Each of the SRFI soil borings in Figure 3 were selected to fill in data gaps in the overall investigation or in response to a regulatory concern. Typical soil sample depths were based on characterizing two intervals. The first interval would represent the highest magnitude of contamination in the fill based on OVM or XRF readings and visual or olfactory observations. The second interval would represent the vertical extent of contamination based on OVM readings less than or equal to background readings beneath the first interval. In some cases, soil sample depths were based on determining the lateral extent of a COC and only consisted of one sample interval.

Soil borings were installed using a Direct Push Technology (DPT) rig. A DPT rig employs both static force (the weight of the vehicle) and a hydraulic percussion hammer to advance sampling and logging tools into the subsurface. A soil boring log was generated during the collection of each soil sample to develop a detailed description of the subsurface lithology. Each boring log was generated by a field geologist in a consistent manner to facilitate future correlation between boreholes. In addition, analysis of these logs aids in determining geologic conditions, the assessment of contaminant distribution, and the eventual evaluation of remedial alternatives for the site. A detailed log for each soil boring is included in Appendix A.

At each boring location, soil samples were collected continuously below the ground surface until a termination depth was reached. The Field Geologist determined the termination depth in the field by implementing the decision-based sampling and analysis strategy as detailed in the SRFI DWPs. During soil boring advancement, a soil coring device was used to produce a relatively undisturbed soil core from which soil characteristics were visually identified. Prior to each use, the soil sampling device was thoroughly decontaminated using the process outlined in the SRFI DWPs. The advancement of the soil coring device followed ASTM #D6282-98 for undisturbed samples. Upon retrieval, the device was opened and its contents were screened with a photo-ionization detector (PID), outfitted with a 10.2 mV lamp calibrated for benzene, and logged by the Field Geologist.

In addition to standard PID screening of soil, cores retrieved from borings in specific areas were screened with a portable field X-Ray Fluorescence meter (XRF), which yielded lead concentrations in ppm. For lead delineation, the first soil sample per boring was collected from the material exhibiting the highest XRF response for lead in ppm and submitted to a NJDEP certified laboratory for confirmation analysis. The second lead delineation sample per boring was collected from an interval stratigraphically beneath the first sample, where the XRF response for lead would be at or below the NJDEP NRDCSCC limit (600 mg/kg).

4.2 Groundwater Investigation

4.2.1 Permanent Groundwater Monitoring Wells

During the course of the SRFI, a total of 24 permanent groundwater monitoring wells were installed across the site (13 shallow and 10 deep wells) by ECDI (see Figure 3). The location and screen depth of each SRFI shallow and deep well was selected by Chevron to determine the horizontal and vertical extent of contamination and to have a better understanding of the site's hydrogeology. SRFI shallow wells were located in areas of the site where additional data was deemed necessary. SRFI deep wells were installed in areas of the site where benzene contamination was known to be highest in existing shallow wells. This was done to determine if existing plumes were sinking below the existing monitoring well network. In addition, SRFI deep wells were located near environmentally sensitive areas along Woodbridge Creek and the Arthur Kill and in some cases along the property border. Furthermore, SRFI deep wells were located in each yard to determine the horizontal and vertical hydraulic gradients across the site.

Prior to monitoring well installation, a soil boring was typically advanced at each monitoring well location to obtain lithologic and organic vapor monitor (OVM) screening data. Following lithologic and OVM data collection, and soil sampling if applicable, a monitoring well was installed in the soil boring following installation procedures detailed in the SRFI DWPs. All detailed boring logs and monitoring well completion forms are included in Appendix A and Appendix B, respectively. Subsequently, each monitoring well was developed, purged, and sampled as per NJDEP guidelines or regulations.

Permanent groundwater monitoring wells are constructed with a two-inch diameter, schedule 40 PVC riser and screen (five feet long, 0.01 inch slot size), with a quartz sand pack (#0) extending one foot above the screened interval, a two-foot bentonite seal on top of the sand pack, and cement-bentonite grout to ground surface around the riser pipe. Macro-core samples were obtained for the entire depth of the pilot boring for lithologic description and field screened with a PID.

To hydraulically isolate each deep well from the upper water-bearing zone, a six-inch diameter steel casing was installed in each borehole as determined by the SAIC Supervisory Geologist. The steel casing was driven and grouted into a confining layer. Once the grout had set inside and around the steel casing, drilling continued through the steel casing, into the native soil, until the well installation depth was reached.

Following installation, all new permanent monitoring wells were developed to a turbid-free discharge by purging a minimum of three well volumes from the well, if practicable. In cases where the new well recharged very slowly or had a minimal yield, a minimum of one well volume of water was removed from the well.

A designated measuring point was marked on the inner casing of each well for surveying and water level measurements. A New Jersey licensed surveyor then determined the vertical and horizontal locations of each new well. The horizontal coordinates were surveyed per location in terms of latitude and longitude or New Jersey State Plane Coordinates, and the vertical elevations were surveyed relative to the National Geodetic Vertical Datum (NGVD). The elevations of the designated measuring point on the inner casing, the top of the outer casing, and ground surface were all included in the survey. Form A and Form B well completion forms were subsequently prepared and submitted to the New Jersey Bureau of Water Allocation. Copies of each Form A and Form B were provided to the NJDEP Bureau of Federal Case Management and to the USEPA, and are included in Appendix B.

Prior to groundwater sampling, the depth to the water table in each well was measured and documented during the course of a single day (February 27, 2007) to determine the groundwater flow direction across the site, and to identify potential receptors and receptor pathways. An electronic water level indicator with a measuring tape divided into incremental measurements of 0.01 feet was used to conduct groundwater gauging. The depth to groundwater was measured from the top of the inner casing at the surveyor's mark and recorded.

Groundwater samples were collected from each new permanent monitoring well during the last quarter of 2006 and/or during the first half of 2007, depending on when each well was installed. Prior to each sampling event, groundwater from each well was removed using a peristaltic pump with dedicated disposable tubing at low flow in accordance with the New Jersey Field Sampling Manual (NJDEP, 2005). As the water was being removed, a Horiba U-22 outfitted with a flow-through cell was used to monitor groundwater quality parameters (pH, temperature, specific conductivity, salinity, turbidity, total dissolved solids (TDS), dissolved oxygen (DO), and oxidation/reduction potential (ORP)) until they stabilized. The peristaltic pump and tubing were then used to collect unfiltered samples for TAL metals and ferrous iron analyses. The ferrous iron sample was analyzed immediately in the field using a HACH DR/820 portable colorimeter with ferrous iron reagent. An additional sample was collected and filtered in the field using a QuickFilter 0.45 micron filter for later total iron analysis. Due to the additional filtration step, the total iron analysis effectively measures the amount of dissolved iron in the sample. Results from filtered/dissolved iron samples were used for comparison with the field-analyzed ferrous iron sample results.

A total of three volume equivalents were then purged from each well using a submersible pump and tubing, in accordance with the New Jersey Field Sampling Manual (NJDEP, 2005b). Wells were allowed sufficient time (not to exceed 24 hours) to recharge to levels suitable for sampling. Unfiltered samples for TCL VOC, TCL SVOC, sulfate,

nitrate/nitrite, chloride, TDS, ammonia, and alkalinity analyses were collected using a dedicated disposable bailer. Finally, each well was again monitored for stabilized in-situ groundwater quality parameters using a Horiba U-22 unit. All samples not analyzed in the field were sent to Lancaster Laboratories, Inc., a New Jersey Certified Laboratory, for analysis.

4.2.2 Temporary Monitoring Wells

During the course of the SRFI, a total of 13 temporary monitoring wells were installed across the site (see Figure 3). Temporary monitoring wells were installed by DPT methods and abandoned within 48 hours or less. Prior to construction, continuous macro-core soil samples were obtained for the entire depth of a pilot boring for lithologic description and OVM screening purposes. Following the pilot boring advancement, each temporary well was constructed of one-inch diameter PVC riser pipe, with a two-foot long, 0.01-inch slot PVC screen. Each screen was set across the water table or deeper, to intersect impacted soil intervals. No sand pack or bentonite seal was used during temporary well installation and the wells were not developed prior to sampling. Each temporary well was surveyed using a portable global positioning system (GPS) as described in the SRFI DWPs, with no Form A or Form B well completion forms. A detailed boring log for each temporary monitoring well location is included in Appendix A.

A groundwater grab sample was collected from each temporary monitoring well using a dedicated, disposable, 0.5-inch, polyethylene bailer. The groundwater samples were placed in appropriate laboratory cleaned sample containers and packed in a cooler with ice for submittal to Lancaster Laboratories, Inc. for analysis.

In an effort to reduce the turbidity in samples obtained through slotted PVC, groundwater samples collected for metals analysis were facilitated through the use of a porous media comprised of high-density polyethylene (HDPE). The groundwater sample was collected through the use of dedicated Teflon tubing, and a peristaltic pump. The groundwater was pumped at low flow rates from the surrounding formation directly into the sample collection bottles.

4.3 Membrane Interface Probe Surveys

During the SRFI, a total of 18 MIP vertical profiles or surveys were conducted in the NF/MY (see Figure 4). Eleven of the 18 MIP profiles were conducted along Woodbridge Creek to optimize monitoring well and well screen placement in AOIs 5 and 6. In addition, seven MIP profiles were conducted in AOI NF2 to minimize the number of soil borings and monitoring wells. Each MIP profile includes a downhole log that records a continuous vertical profile of the subsurface temperature, specific conductivity, and hydrocarbons. In some cases, a companion soil boring was completed at each MIP profile location to collect soil samples for analytical and lithologic comparison with the specific conductivity borehole log. Appendix C contains all the SRFI MIP survey logs.

A MIP is a down-hole sensor that volatilizes VOCs through a permeable membrane to detect volatile contaminants in the subsurface. A thin membrane is impregnated into a stainless steel screen on the face of the probe. This membrane is heated to 100 to 120 degrees Celsius (°C), which leads to quick diffusion of volatile contaminants across the membrane into the carrier gas line. The carrier gas (typically N₂) transfers the contaminants to gas chromatograph (GC) detectors at the surface, including a PID and flame ionization detector (FID). PID and FID detectors respond to aromatic VOCs. As the MIP sensor is advanced, a continuous, depth-correlated digital record of detector response is recorded. This record provides information about relative VOC concentration as a function of depth.

Field calibration of MIP detector response versus groundwater VOC concentration was developed as a means of assigning quasi-quantitative measures to MIP detector response. The primary objective of this reconnaissance effort was to gain a higher degree of data density. Accordingly, as part of the approach employed during this project, a qualitative instrument calibration was performed prior to each probing. This resulted in a VOC detection limit of approximately 100 parts per billion (ppb) total VOC.

The system will not produce false-positives; thus, detector response can be considered definitive for the presence of VOCs. However, analytical certainty required follow-up sampling within the MIP-guided VOC zones using confirmatory sampling and analysis at an off-site analytical laboratory.

4.4 Three-Dimensional Data Visualization Computer Modeling

4.4.1 Soil Data Modeling

Soil data modeling was conducted using the commercially available Rockworks software package. The Rockworks site soil model for the Refinery's NF/MY and EY contains 1,801 boring locations and accompanying information related to lithology, stratigraphy, organic vapor readings, and soil sample data. There were four main steps in producing this dynamic final model for the Refinery:

1. Gathering of historical data and its entry into Rockworks format;
2. Modeling of that data for the purposes of planning the SRFI;
3. Gathering of a final set of field data to complete the investigation; and
4. Completion of the site model with the new data.

The first step in the modeling process was to gather the soil boring data collected (pre-SRFI) and enter it into Rockworks format. A download of location coordinates from CEMC's existing Locus Focus database and quality assurance of the locations was completed to begin the process. Then, lithologic, stratigraphic, and soil vapor PID data was compiled from hundreds of the existing historical boring logs. A set of standardized terms for the description of lithologic and stratigraphic information was decided upon to allow for the collective modeling of approximately 30 years worth of diverse geologic

descriptions. Once this was complete, data for a select group of COCs was downloaded from the Locus Focus database. The data was then evaluated for quality assurance. The COC data downloaded from Locus Focus included those discussed in Table 6-1 of the November 2003 Full RCRA Facility Investigation Report and described as "Greater Than Applicable Delineation Criteria".

The second step in the modeling process was to run models of the completed data set with appropriate algorithms using Rockworks. Soil vapor models for organic vapor were run using the inverse distance anisotropic algorithm. Three-dimensional soil vapor models were then converted into two-dimensional maps. Cross sections were also produced with sections of the three-dimensional soil vapor models in the background and presented in conjunction with soil boring data including lithology, stratigraphy, and soil sample data. Soil models of benzene, benzo(a)pyrene, lead, and arsenic were completed using an inverse distance weighted algorithm. These models were also converted into two-dimensional maps.

As the third step in the modeling process, two-dimensional maps, three-dimensional models, and cross sections were all used in conjunction to plan the work completed during the SRFI.

The fourth and final step in the process was to add the SRFI data collected during the investigation into the Rockworks site model. In addition to the lithology, stratigraphy, soil vapor, and soil sample data, portable field XRF data was collected for lead. This XRF data was modeled three-dimensionally in the same manner as the soil vapor data. Cross sections were then produced with sections of the three-dimensional XRF model for lead in the background and presented in conjunction with soil boring data including lithology, stratigraphy, and lead soil sample data.

4.4.2 Groundwater Modeling

Groundwater COCs were modeled using a different approach than the soil model. Groundwater data can be highly anomalous, requiring the data to be modeled using the logarithm of the actual groundwater values. As such, a kriging algorithm was used to extrapolate the data between the actual groundwater sample locations. The isoconcentration maps that appear in this report were created from the extrapolated data grid.

This modeling technique was used to develop two-dimensional groundwater contour maps and contaminant distribution maps. Some COCs were not found in significant concentrations or aerial extent, rendering them unsuitable for modeling. Only COCs such as ammonia, arsenic, benzene, cyclohexane, lead, and methylcyclohexane were found in groundwater at a distribution sufficient to create a proper model, and are presented in this report.

5. SRFI Findings

This section presents the findings of the soil and groundwater investigations undertaken as part of the SRFI. A major goal of the SRFI investigation was to complete the delineation of the horizontal and vertical extent of the contamination at the Chevron Perth Amboy site. This was accomplished through reviewing the existing data set, identifying potential data gaps, and obtaining the additional data necessary to fill the gaps. The SRFI data was then incorporated with the existing data set into a final model which shows the nature and extent of contamination for the Refinery.

As presented in Section 2, the extent of contamination was determined based on the SRFI Evaluation Criteria. However, in the case of benzene and lead in soil, the NJDEP NRDCSCC was used to determine the extent of contamination. In addition, the horizontal extent of contamination was typically limited to a 200 foot sample spacing based on previous discussions with NJDEP.

5.1 SRFI Soil Findings – North Field/Main Yard

During the SRFI, 81 soil borings (including MIP points) were installed in the NF/MY to supplement the original RFI boring data (Figure 3). Based on the data from these SRFI soil borings as well as historical soil borings, four yard-wide maps were created of the entire NF/MY depicting OVM readings and lead, arsenic, and benzo(a)pyrene concentrations in soil (see Figure 4 through Figure 7). These COCs were chosen for illustration based on their occurrence across the site and their risk to human health. In addition, these compounds have historically been primary indicators for other contaminants (e.g., xylene, benzo(a)anthracene, etc.) present in the soil. Maps depicting the distribution of benzene in soil are presented for each individual AOI in the following sections. Appendix D contains all of the analytical soil data collected during the SRFI. Appendix E contains a Data Validation Report with the results of the QA/QC analysis for the analytical data.

5.1.1 AOI NF2

SRFI investigative work conducted across NF2 and its vicinity included a total of 10 soil borings, seven MIP points (S2101 through S2107 to verify the 3-D model and validate sampling strategy), two permanent shallow groundwater monitoring wells, and one permanent dual-cased deep groundwater monitoring well, installed using the decision-based sampling and analysis strategy as detailed in the October 2006 SRFI DWP. This soil and groundwater investigation was conducted to further delineate COCs across NF2. Table 5 lists the 10 soil borings advanced in NF2 during the SRFI.

Two soil samples were collected at each boring location as specified in the NF/MY SRFI DWP, with the exception of one boring (S2118) where four soil samples were collected. The first soil sample was taken in the core interval exhibiting the greatest potential for petroleum hydrocarbon impacted soil based upon visual, olfactory, and PID response. This first sample was typically collected from the shallow, fill material. The second

Table 5. NF2 SRFI Soil Borings

Boring ID	Well ID	Work Plan ID	Analytical Parameter(s)	Sample Depths (ft. bgs)	
S2101	N/A	NF2PB7	VOCs	1.5-2.0	12.0-12.5
S2102	N/A	NF2PB6	VOCs	2.5-3.0	14.5-15.0
S2103	MW-242	NF2PB1	VOCs	3.0-3.5	14.5-15.0
S2105	N/A	NF2PB5	VOCs	11.5-12.0	13.5-14.0
S2106	N/A	NF2PB3	VOCs	2.5-3.0	14.5-15.0
S2107	N/A	NF2PB2	VOCs	8.5-9.0	14.5-15.0
S2110	N/A	NF2PB8	VOCs	4.0-4.5	14.5-15.0
S2111	N/A	NF2PB10	VOCs	10.0-10.5	14.5-15.0
S2112	N/A	NF2PB9	VOCs	9.5-10.0	14.5-15.0
S2118	MW-240	RW-02D	VOCs, SVOCs, Metals	7.5-8.0	19.0-19.5
				25.0-25.5	29.5-30.0

N/A = Not Applicable

sample was collected from the next deeper core interval exhibiting no potential for petroleum hydrocarbon impacted soil based upon visual, olfactory, and PID response. Soil samples were then transferred into appropriate laboratory cleaned sample containers and placed in a cooler with ice for laboratory submittal.

A total of 22 soil samples (and one duplicate) were collected from the 10 soil borings advanced in the NF2 vicinity. Analytical parameters included TCL VOCs +10 (EPA Method SW-846 8260B), TCL SVOCs +20 (EPA Method SW-846 8270C), TAL metals (EPA Method SW-846 6010B), and soil moisture (EPA 160.3).

NF2 Lithology and OVM Observations

The lithology within NF2 is characterized in general by the following stratigraphic progression from ground surface to boring termination; red brown silt (0 to 5.0 ft. bgs), gray silt, sandy silt, and clayey silt (5.0 to 10.0 ft. bgs), intermittent brown peat (10.0 to 13.0 ft. bgs), underlain by red brown silty clay (13.0 to 15.0 ft. bgs). Although discontinuous across the area, the peat is generally encountered at relatively shallow depths (5.0 to 6.0 ft. bgs) in the northern part of NF2 (S2101), and at greater depth (10.0 to 13.0 ft. bgs) to the west of Tank 329 (S2111, S2112, and S2118). Elsewhere on the Chevron property, this peat is typically underlain by a gray silty clay and is referred to as "Clay Horizon A" throughout this SRFI Report. Petroleum staining and odor is occasionally encountered in the borings and is generally located between 7.0 to 10.0 ft. bgs. OVM readings across the area were generally between 0 to 50 ppm, with the highest reading (841 ppm) identified in S2111 at a depth of 10.0 to 10.5 ft. bgs (see Figure 8). Only one foot below this interval, OVM readings decreased to 0 ppm at a depth of 11.0 to 11.5 ft. bgs.

Seven MIP points were collected within NF2 at borings S2101 through S2107. These seven MIP points were used to verify the three-dimensional visualization computer

model of NF2 and to verify the sampling strategy. The findings of these MIP points are discussed in Section 5.5.

NF2 Soil Analytical Results

As shown in Table 6 and Appendix D, none of the samples collected in the NF2 vicinity contained concentrations of VOCs or SVOCs in excess of the NJDEP NRDCSCC. However, five samples did exceed the RFI Evaluation Criteria; three samples for benzene, one for xylene, and two for iron. Sample S2107E1 was collected between 8.0 to 8.5 ft. bgs, and contained concentrations of benzene (1.1 mg/kg) and xylene (68 mg/kg) which exceed the RFI Evaluation Criteria of 1 mg/kg and 67 mg/kg respectively, but are below the current NJDEP NRDCSCC of 13 mg/kg, and 1,000 mg/kg respectively. Boring S2107 is located immediately adjacent to the south of Tank 316, as depicted on Figure 9. There was an OVM reading of 403 ppm associated with this sample interval. The location is depicted as having OVM readings of over 316 ppm on Figure 8.

Table 6. AOI NF2 – Summary of SRFI Soil Analytical Results

Sample ID	Sample Depth (ft. bgs.)	VOC Exceedances (mg/kg)	SVOC Exceedances (mg/kg)	Metals Exceedances (mg/kg)
S2101A4	1.5-2.0	None	NA	NA
S2101G1	12.0-12.5	None	NA	NA
S2102B2	2.5-3.0	None	NA	NA
S2102H2	14.5-15.0	None	NA	NA
S2103B3	3.0-3.5	None	NA	NA
S2103H2	14.5-15.0	None	NA	NA
S2105F4	11.5-12.0	None	NA	NA
S2105G4	13.5-14.0	None	NA	NA
S2106B2	2.5-3.0	None	NA	NA
S2106H2	14.5-15.0	None	NA	NA
S2107E1	8.5-9.0	Benzene (1.1)* Xylene (68)*	NA	NA
S2107H2	14.5-15.0	None	NA	NA
S2110C1	4.0-4.5	None	NA	NA
S2110H2	14.5-15.0	None	NA	NA
S2111F1	10.0-10.5	Benzene (1.5)*	NA	NA
S2111H2	14.5-15.0	None	NA	NA
S2112E4	9.5-10.0	Benzene (4.5)*	NA	NA
S2112H2	14.5-15.0	None	NA	NA
S2118D4	7.5-8.0	None	None	None
S2118J3	19.0-19.5	None	None	Fe (29,400)*
S2118M3	25.0-25.5	None	None	None
S2118O4	29.5-30.0	None	None	Fe (39,300)*

*Exceeds RFI Evaluation Criteria only; does not exceed NJDEP NRDCSCC

NA = Not Analyzed

Approximately 200 feet north-northwest, two sample locations (S2111 and S2112) contained concentrations of benzene (1.5 mg/kg and 4.5 mg/kg, respectively) exceeding the RFI Evaluation Criteria of 1 mg/kg, but below the current NJDEP NRDCSCC of 13 mg/kg. Sample S2111F1 was collected between 10.0 to 10.5 ft. bgs, and yielded an OVM reading of 841 ppm. Sample S2112E4 was collected between 9.5 to 10.0 ft. bgs, and yielded an OVM reading of 478 ppm. Both sample locations are depicted as having OVM readings of over 316 ppm on Figure 8.

Six cross sections of the NF2 Study area are depicted on Figure 8 and Figure 8A. During Chevron's analysis of all NF2 historical soil data, it was evident that horizontal and vertical delineation of VOCs in soil had not been achieved as seen in the historical cross sections shown on Figure 8A. However, this analysis did indicate the location of data gaps to be studied during the SRFI soil investigation conducted in 2006. As such, soil samples collected during the SRFI enabled Chevron to complete the horizontal and vertical delineation of VOCs across NF2 as depicted on the SRFI cross sections on Figure 8A, which included data from both the SRFI and historical soil data.

5.1.2 AOI NF3A

SRFI investigative work conducted across NF3A and its vicinity included a total of 14 soil borings, one MIP point, and one permanent shallow groundwater monitoring well installed using the decision-based sampling and analysis strategy as detailed in the October 2006 SRFI DWP. This soil and groundwater investigation was conducted to further delineate COCs across NF3A. Table 7 lists the 14 soil borings advanced in NF3A during the SRFI.

Table 7. NF3A SRFI Soil Borings

Boring ID	Work Plan ID	Parameter(s)	Sample Depths (ft. bgs)	
S2119	NF3APB5	VOCs, SVOCs, As	8.5-9.0	19.0-19.5
S2124	NF3APB8	VOCs As	2.5-3.0	19.5-20.0
S2130	S2130	VOCs, SVOCs, Metals	10.0-10.5	11.5-12.0
S2131	S2131	VOCs, SVOCs, Metals	6.0-6.5	13.5-14.0
S2135	NF3APB10	VOCs, SVOCs	5.5-6.0	14.5-15.0
S2136	NF3APB11	VOCs, SVOCs, As	6.0-6.5	7.0-7.5
			12.0-12.5	
S2137	NF3APB9	VOCs, As	2.5-3.0	4.5-5.0
S2138	NF3APB3	VOCs, SVOCs, Metals	2.5-3.0	4.0-4.5
S2139	NF3APB2	VOCs, SVOCs, Metals	4.0-4.5	12.0-12.5
S2145	NF3APB4	VOCs, SVOCs, Metals	4.5-5.0	9.0-9.5
S2416	NF3APB7	VOCs, SVOCs, Metals	11.0-11.5	16.0-16.5
S2419	NF3APB1	VOCs, SVOCs	5.5-6.0	
S2443	S2443	SVOCs	12.5-13.0	
S2444	S2444	VOCs	18.5-19.0	

A total of two soil samples were typically collected at each boring location as specified in the NF/MY SRFI DWP, with the exception of boring S2136, where three depth intervals were sampled, and borings S2419, S2443, and S2444 where only one depth interval was sampled. The first soil sample was taken in the core interval exhibiting potential for petroleum hydrocarbon impacted soil based upon visual, olfactory, and PID response. This first sample was typically collected from the shallow fill material. The second sample was collected from the next deeper core interval exhibiting no potential for petroleum hydrocarbon impacted soil, based upon visual, olfactory, and PID response. Soil samples were then transferred into appropriate laboratory cleaned sample containers and placed in a cooler with ice for laboratory submittal.

A total of 26 soil samples (and two duplicates) were collected from the 16 soil borings advanced in the NF3A vicinity. Analytical parameters included TCL VOCs +10 (EPA Method SW-846 8260B), TCL SVOCs +20 (EPA Method SW-846 8270C), TAL metals (EPA Method SW-846 6010B), total arsenic (EPA Method SW-846 6010B), and soil moisture (EPA 160.3).

NF3A Lithology and OVM Observations

The lithology within NF3A is characterized in general by the following stratigraphic progression from ground surface to boring termination; red brown sand and clay (approximately 0 to 5.0 ft. bgs), intermittent black sand (approximately 5.0 to 10.0 ft. bgs), intermittent gray clay and silty clay (approximately 5.0 to 10.0 ft. bgs), red brown sandy clay and silty clay (approximately 10.0 to 15.0 ft. bgs), underlain by a brown peat/gray organic clay (Clay Horizon A) (approximately 15.0 to 20.0 ft. bgs). Black sand and silt with petroleum staining and odor is intermittent across NF3A, and is generally encountered immediately above Clay Horizon A at various depths (3.0 to 12.0 ft. bgs) across NF3A. The petroleum staining and odor terminates abruptly at the Clay Horizon A interface, and has not been observed penetrating into this native material. Although discontinuous across the area, Clay Horizon A is generally encountered at shallow depth (5.0 to 8.0 ft. bgs) in the northern and western parts of NF3A (S2090, S2145, and S2419), and at greater depth (14.5 to 18.0 ft. bgs) in the vicinity of Tank 326 (S2119, S2135, S2136, and S2137). A significant thickness of catalyst beads was encountered in several borings including S2135, S2136, and S2443, at depths ranging from 2.0 to 14.0 ft. bgs. The catalyst bead areas typically showed signs of petroleum odor and staining.

OVM readings across the NF3A Area were generally between 0 to 50 ppm. Three boring locations in NF3A exhibited OVM concentrations above 1,000 ppm (S2419, S2443, and S2444) (see Figure 10).

The highest OVM reading in NF3A (1,922 ppm) was measured in S2444 at a depth of 9.5 to 10.0 ft. bgs, in a black fine to coarse sand with petroleum odor and staining. The OVM readings dropped to 41.2 ppm one foot below this depth, at 11.0 to 11.5 ft. bgs.

Approximately 150 feet to the south, soil boring S2443 yielded an OVM reading of 1,426 ppm from a layer of catalyst beads with petroleum odor and staining at the same depth

interval (9.5 to 10.0 ft. bgs). The OVM readings dropped to 0.0 ppm two feet below this depth, at 12.0 to 12.5 ft. bgs.

In soil boring S2419, an OVM reading of 1,228 ppm was associated with a black sand horizon with petroleum odor and staining, at a depth of 5.5 to 6.0 ft. bgs. Within three feet below this horizon, OVM readings decreased to 7.5 ppm at Clay Horizon A (8.5 to 9.0 ft. bgs).

NF3A Soil Analytical Results

Soil from three boring locations in the NF3A vicinity contained concentrations of VOCs in excess of the NJDEP NRDCSCC (S2131, S2139, and S2419). Concentrations of SVOCs in excess of the NJDEP NRDCSCC were also detected in three boring locations in the NF3A vicinity (S2136, S2139, and S2419). Of the 22 soil samples analyzed for total metals or arsenic only, three samples (2145C2, 2137C2, and 2119E2) contained concentrations of arsenic in excess of the NJDEP NRDCSCC. Table 8 and Appendix D summarize soil analytical data from the NF3A vicinity.

Soil boring location S2131 is located in the central portion of NF3A, midway between Tanks 327 and 328. Sample S2131G4 was collected between 13.5 to 14.0 ft. bgs, and contained benzene (15 mg/kg) in a concentration exceeding the NJDEP NRDCSCC (13 mg/kg). Clay Horizon A, with an OVM reading of 20.1 ppm was encountered at this interval. An additional soil boring (S2444) was advanced in the original S2131 location to collect a soil sample below the 13.5 to 14.0 ft. bgs interval and determine the vertical extent of the contamination. Soil sample S2444J2 was collected between 18.5 to 19.0 ft. bgs, and provides vertical delineation for this location, as it contained no VOCs in excess of the NJDEP NRDCSCC. The location of S2131/S2444 is depicted on Figure 11 as having a benzene concentration above 13 mg/kg.

A shallow soil sample (S2139C1) was collected from the 4.0 to 4.5 ft. bgs interval, immediately adjacent to the east of Tank 328, and contained benzene (14 mg/kg) and xylene (1,300 mg/kg) in excess of the NJDEP NRDCSCC for these compounds (13 mg/kg and 1,000 mg/kg, respectively). A black fine to coarse sand with petroleum odor and staining yielding an OVM reading of 414 ppm was encountered at this interval. Sample S2139C1 also contained ethylbenzene (330 mg/kg) in a concentration below the NJDEP NRDCSCC, but above the Evaluation Criteria (100 mg/kg). In addition, the SVOC compound benzo(a)pyrene (1.7J mg/kg) was detected in S2139C1 at a concentration above the NJDEP NRDCSCC (0.66 mg/kg). The compounds benzo(a)anthracene (1.9J mg/kg) and benzo(b)fluoranthene (1.7J mg/kg) were detected in concentrations below the NJDEP NRDCSCC, but above the Evaluation Criteria (0.9 mg/kg and 0.9 mg/kg, respectively). Sample S2139G1 was collected from 12.0 to 12.5 ft. bgs, and provides vertical delineation for this location, as it contained no VOCs, SVOCs, or metals in excess of the NJDEP NRDCSCC. Location S2139 is depicted on Figure 11 as having a benzene concentration above 13 mg/kg.

Table 8. AOI NF3A Soil Analytical Results

Sample ID	Sample Depth (ft. bgs)	VOC Exceedances (mg/kg)	SVOC Exceedances (mg/kg)	Metals Exceedances (mg/kg)
S2119E2	8.5-9.0	None	None	As (20.1)
S2119J3	19.0-19.5	None	None	None
S2124B2	2.5-3.0	None	NA	None
S2124J4	19.5-20.0	None	NA	None
S2130F1	10.0-10.5	None	None	None
S2130F4	11.5-12.0	None	None	None
S2131D1	6.0-6.5	NA	None	None
S2131G4	13.5-14.0	Benzene (15)	None	None
S2135C4	5.5-6.0	None	None	NA
S2135H2	14.5-15.0	None	None	NA
S2136D1	6.0-6.5	None	Benzo(a)anthracene (18) Benzo(a)pyrene (31) Benzo(b)fluoranthene (9.5) Benzo(k)fluoranthene (1.7)* Dibenz(a,h)anthracene (6.0) Indeno(1,2,3-cd)pyrene (6.8)	None
S2136D3	7.0-7.5	Benzene (2.3)*	Benzo(a)anthracene (45) Benzo(a)pyrene (70) Benzo(b)fluoranthene (22) Chrysene (76) Dibenz(a,h)anthracene (12) Indeno(1,2,3-cd)pyrene (18)	None

Table 8. AOI NF3A Soil Analytical Results

Sample ID	Sample Depth (ft. bgs)	VOC Exceedances (mg/kg)	SVOC Exceedances (mg/kg)	Metals Exceedances (mg/kg)
S2136G1	12.0-12.5	None	Benzo(a)anthracene (34) Benzo(a)pyrene (38) Benzo(b)fluoranthene (12) Benzo(k)fluoranthene (2.7)* Chrysene (52) Indeno(1,2,3-cd)pyrene (9)	None
S2137B2	2.5-3.0	None	NA	None
S2137C2	4.5-5.0	None	NA	As (76.1)
S2138B2	2.5-3.0	None	None	None
S2138C1	4.0-4.5	None	None	None
S2139C1	4.0-4.5	Benzene (14) Ethylbenzene (330)* Xylene (1,300)	Benzo(a)anthracene (1.9J)* Benzo(a)pyrene (1.7J) Benzo(b)fluoranthene (1.7J)*	None
S2139G1	12.0-12.5	None	None	None
S2145C2	4.5-5.0	Benzene (2.1)*	None	Arsenic (30.3)
S2145E3	9.0-9.5	Benzene (2.7J)*	None	None
S2416F3	11.0-11.5	None	None	None
S2416I1	16.0-16.5	None	None	None
S2419C4	5.5-6.0	Benzene (24)	Benzo(a)anthracene (1.3)* Benzo(a)pyrene (0.93) Benzo(b)fluoranthene (1.0)*	NA
S2443G2	12.5-13.0	NA	None	NA
S2444J2	18.5-19.0	None	NA	NA

*Exceeds RFI Evaluation Criteria only; does not exceed NJDEP NRDCSCC.

NA = Not Analyzed

Approximately 75 feet northeast of Tank 328, soil boring S2419 was advanced to a depth of 9.0 ft. bgs, and one sample (S2419C4) was collected from the 5.5 to 6.0 ft. bgs interval. Sample S2419C4 contained benzene (24 mg/kg) at a concentration above the NJDEP NRDCSCC (13 mg/kg). In addition, benzo(a)pyrene (0.93 mg/kg) was detected at a concentration above the NJDEP NRDCSCC (0.66 mg/kg).

Benzo(a)anthracene (1.3 mg/kg) and benzo(b)fluoranthene (1 mg/kg) were detected in S2419C4 at concentrations below the NJDEP NRDCSCC, but above the Evaluation Criteria (0.9 mg/kg and 0.9 mg/kg, respectively). Sample S2419C4 was collected from a black fine to coarse gravelly sand with petroleum odor and staining, and yielded an OVM reading of 1,228 ppm. Clay Horizon A exists immediately below this black sand at 6.0 ft. bgs, but no vertical delineation sample was collected. However, adjacent boring locations S2139, positioned 75 feet southwest of S2419 and S2145, positioned 150 feet northeast of S2419 both encountered native soil horizons at depths between 11.0 to 8.0 ft. bgs, respectively. Vertical delineation samples at both S2139 and S2145 at depths of 9.0 to 9.5 ft. bgs and 12.0 to 12.5 ft. bgs, respectively, indicate no VOCs or SVOCs in excess of the NJDEP NRDCSCC. Additionally, Clay Horizon A was encountered at 9.0 ft. bgs in S2145, and approximately the same depth (6.0 ft. bgs) in S2419. Therefore, Chevron concludes that vertical contamination in the S2419 vicinity does not extend below 12 ft. bgs.

Arsenic was detected in concentrations above the NJDEP NRDCSCC of 20 mg/kg in samples S2119E2 (20.1 mg/kg), S2137C2 (76.1 mg/kg), and S2145C2 (30.3 mg/kg), as depicted in Table 8.

Four cross sections of the NF3A Area are depicted on Figure 10 and Figure 10A. During Chevron's analysis of all NF3A historical soil data, it was evident that horizontal and vertical delineation of VOCs in soil had not been achieved as seen in the historical cross sections shown on Figure 10A. However, this analysis did indicate the location of data gaps to be studied during the SRFI soil investigation conducted in 2006. As such, soil samples collected during the SRFI enabled Chevron to complete the horizontal and vertical delineation of VOCs across NF3A as depicted on SRFI cross sections on Figure 10A, which included data from both the SRFI and historical soil data.

5.1.3 AOI NF3B

SRFI investigative work conducted across NF3B and its vicinity included 23 soil borings installed using the decision-based sampling and analysis strategy as detailed in the October 2006 SRFI DWP. This soil investigation was conducted to further delineate COCs across NF3B. Table 9 summarizes the 23 soil borings advanced in NF3B during the SRFI.

In addition to standard OVM screening of soil, cores retrieved from borings in the NF3B area were screened with an XRF meter, which yielded lead concentrations in ppm.

Table 9. NF3B SRFI Soil Borings

Boring ID	Work Plan ID	Parameter(s)	Sample Depths (ft. bgs)	
S2140	NF3BPB5	VOCs, SVOCs, Pb, TEL	5.0-5.5	15.5-16.0
S2141	NF3BPB3	Pb, TEL	3.5-4.0	6.0-6.5
S2142	NF3BPB2	Pb, TEL	3.5-4.0	8.5-9.0
S2143	NF3BPB4	VOCs, Pb, TEL	2-2.5.0	6.5-7.0
S2144	NF3APB6	VOCs, SVOCs, Metals	3.5-4.0	6.5-7.0
S2436	N/A	VOCs, Pb	7.0-7.5	8.5-9.0
			11.0-11.5	12.5-13.0
S2437	NF3BPB1	Pb	7.0-7.5	12.0-12.5
			12.5-13.0	14.5-15.0
S2438	N/A	BTEX	4.0-4.5	6.0-6.5
S2439	N/A	BTEX	8.0-8.5	
S2440	N/A	BTEX, Pb	3.0-3.5	6.0-6.5
			6.5-7.0	
S2441	N/A	BTEX, Pb	3.0-3.5	4.0-4.5
			4.5-5.0	7.0-7.5
S2445	N/A	BTEX, Pb	2.5-3.0	3.0-3.5
			7.5-8.0	8.0-8.5
S2446	N/A	None	None	
S2447	N/A	Pb	7.0-7.5	11.0-11.5
S2448	N/A	None	None	
S2449	N/A	BTEX, Pb	3.5-4.0	6.0-6.5
			7.0-7.5	7.5-8.0
S2450	N/A	BTEX, Pb	1.5-2.0	2.5-3.0
			6.0-6.5	8.5-9.0
S2552	N/A	Pb	2.5-3.0	3.0-3.5
			4.0-4.5	7.5-8.0
S2553	N/A	BTEX, Pb	1.5-2.0	2.5-3.0
			3.0-3.5	3.5-4.0
S2554	N/A	BTEX, Pb	2.0-2.5	3.0-3.5
			6.5-7.0	8.0-8.5
S2555	N/A	BTEX, Pb	3.5-4.0	4.0-4.5
			6.5-7.0	7.5-8.0
S2556	N/A	Pb	3.0-3.5	5.5-6.0
S2557	N/A	BTEX, Pb	1.0-1.5	6.5-7.0
			7.5-8.0	

Not all parameters were analyzed for each depth interval

N/A = Not Applicable

Two to four soil samples were collected at each boring location as specified in the NF/MY SRFI DWP, with the exception of boring S2439 where only one depth interval was sampled, and borings S2446 and S2448 where no samples were collected. Soil samples were collected for laboratory analysis to delineate VOCs and lead across the

area. The sampling strategies for VOC and lead delineation were based upon the results obtained from field screening using the PID and XRF meters.

VOC delineation was conducted using two samples collected from each boring. The first soil sample was taken in the core interval exhibiting potential for petroleum hydrocarbon impacted soil based upon visual, olfactory, and PID response. This first sample was typically collected from the shallow, fill material. The second VOC sample was collected from the next deeper core interval exhibiting no potential for petroleum hydrocarbon impacted soil, based upon visual, olfactory, and PID response. Soil samples were then transferred into appropriate laboratory cleaned sample containers and placed in a cooler with ice for laboratory submittal.

Lead delineation and sampling was conducted as discussed in Section 4.1. In order to determine how field XRF screening correlates to actual laboratory analyses of the same soil, laboratory results were compared to XRF readings for specific intervals at boring location S2437. At this boring location, one soil sample was collected from an interval exhibiting a lead concentration above the NJDEP NRDCSCC based on field XRF screening. Three additional samples were collected from intervals exhibiting lead concentrations below the NJDEP NRDCSCC based on field XRF screening. Table 10 summarizes the correlation between field XRF screening and laboratory analytical data for samples collected from boring S2437.

Table 10. S2437 XRF Screening Data vs. Laboratory Total Pb Analytical Data

Depth Interval (ft. bgs)	XRF Readings (ppm)	Laboratory Total Pb (µg/L)
7.0-7.5	701	781
12.0-12.5	45	38.9
12.5-13.0	6	12.8
14.5-15.0	<13	7.29

Based on this comparison, the field XRF screening is an accurate method of determining lead concentrations in these soils, and therefore a valuable screening tool for lead delineation in this area.

A total of 64 soil samples (and four duplicates) were collected from all 23 soil borings advanced in the NF3B vicinity. Analytical parameters included TCL VOCs +10 (EPA Method SW-846 8260B), BTEX (EPA Method SW-846 8260B), TCL SVOCs +20 (EPA Method SW-846 8270C), TAL metals (EPA Method SW-846 6010B), total lead (EPA Method SW-846 6010B), TEL (EPA Method SW-846 8270C), and soil moisture (EPA 160.3).

NF3B Lithology, OVM and XRF Observations

The lithology within NF3B is characterized in general by the following stratigraphic progression from ground surface to boring termination; gray brown sand and clay (approximately 0 to 5.0 ft. bgs), black sand (approximately 3.0 to 6.0 ft. bgs), peat/gray

organic clay (Clay Horizon A) (approximately 6.0 to 10.0 ft. bgs), underlain by red brown fine to coarse sand and red brown clay (approximately 10.0 to 16.0 ft. bgs). The black sand and silt with petroleum staining and odor is observed frequently across NF3B at various depths, and is generally encountered immediately above Clay Horizon A. The black sand is generally encountered at greater depth in an eastward direction. The petroleum staining and odor associated with the black sand terminates abruptly at the Clay Horizon A interface, and has not been observed penetrating beneath this native material. Although discontinuous across the area, Clay Horizon A is generally encountered at shallow depth (5.0 to 8.0 ft. bgs) in the north-central portion of NF3B (S2440 and S2441), and is encountered at greater depth in an eastward direction (S2436 and S2437). In the southern portion of NF3B, peat is not encountered at all (S2554 and S2555).

OVM readings across the NF3B Area exceeded 100 ppm in at least one depth interval at 14 of the 23 locations (see Figure 12). Three boring locations in NF3B exhibited OVM concentrations above 1,000 ppm (S2436, S2554, and S2557).

The highest OVM reading in NF3B (1,725 ppm) was observed in S2436 at a depth of 3.5 to 4.0 ft. bgs, in a red brown fine to coarse sand. Immediately below this interval is a black fine to coarse sand with petroleum odor and staining that yielded an OVM reading of 1,159 ppm. This black sand is continuous to approximately 10.0 ft. bgs where it is intersected by Clay Horizon A. The OVM readings gradually decreased from 1,159 ppm at 4.0 to 4.5 ft. bgs, to 6.2 ppm immediately above Clay Horizon A.

Soil borings S2554 and S2557 are located adjacent to the south of Tank 302, approximately 200 and 150 feet southwest from S2436, respectively. The highest OVM readings in both S2554 (1,137 ppm) and S2557 (1,225 ppm) were measured in a dark gray sandy silt with petroleum odor and staining, between 2.0 to 3.5 ft. bgs. In S2554, the OVM reading dropped to 18.2 ppm, 0.5 feet below the 1,137 OVM reading, in gray clay with no petroleum odor or staining. At S2557, the dark gray sandy silt with petroleum odor and staining extended to a depth of 6.5 ft. bgs. OVM readings decreased gradually through this soil, and reached 0 ppm at a depth of 7.5 ft. bgs in a red brown fine to coarse clayey sand.

The field XRF screening revealed lead concentrations above the NJDEP NRDCSCC (600 mg/kg) in 11 of the 18 soil borings screened. In general, the highest lead concentrations at each boring location in NF3B were found between 2.0 to 4.0 ft. bgs, which is within the gray to brown silty sands found at ground surface, and the underlying black silty sands. Lead was encountered at greater depth (7.0 to 9.0 ft. bgs) in borings S2436, S2437, and S2447. This is likely due to the subsequent addition of road base fill material over these areas. Figure 13 depicts borings with XRF concentrations greater than 600 ppm across the NF3B Area. As depicted, most of the shallow lead contamination surrounds the northern and western sides of Tank 302, with a small, detached area of additional lead impacted soil located approximately 75 feet east of Tank 302 (in the vicinity of S2436).

NF3B Soil Analytical Results

None of the soil samples collected in the NF3B vicinity contained concentrations of VOCs in excess of the NJDEP NRDCSCC. However, soil samples from six boring locations in this area (S2143, S2436, S2440, S2445, S2449, and S2557) did contain concentrations of VOCs in excess of the SRFI Evaluation Criteria. No SVOCs were detected in concentrations exceeding the NJDEP NRDCSCC in the four samples analyzed for SVOCs. Of the 40 soil samples analyzed for total lead, eight borings (S2140, S2142, S2143, S2436, S2437, S2441, S2450, and S2554) contained total lead in concentrations exceeding the NJDEP NRDCSCC. Two samples contained concentrations of total lead exceeding the RFI Evaluation Criteria only. Eight samples were analyzed for TEL; however, no detectable concentration was present in any of these samples. Table 11 and Appendix D summarize soil analytical data from the NF3B vicinity.

Soil boring locations at which the concentration of benzene was greater than 1 mg/kg are depicted on Figure 14. The soil boring locations with benzene greater than 1 mg/kg are primarily to the east of Tank 302. Isolated benzene over 1 mg/kg in soil is also present, and is depicted at locations S2143 and S2445 to the northwest, and location S2557 to the southeast of Tank 302. The concentration of xylene exceeds the SRFI Evaluation Criteria only at locations S2143, S2436, S2440, and S2557. The concentration of ethylbenzene exceeds the SRFI Evaluation Criteria only at location S2436. The benzene concentrations plotted on Figure 14 correlate well with a plot of OVM data collected across the area, as depicted in Figure 12. OVM readings greater than 316 ppm correspond to benzene greater than 1 mg/kg at boring locations S2143, S2436, and S2557. An OVM reading greater than 100 ppm corresponds to a benzene concentration greater than 1 mg/kg at boring location S2445. No OVM readings above 100 ppm were observed at S2449; however, a benzene concentration greater than 1 mg/kg (5.1 mg/kg in sample S2449D3) was detected at this location. Vertical delineation of VOCs has been achieved across NF3B as evidenced by a combination of historical and SRFI soil boring data. The supplemental boring locations conducted during this SRFI demonstrate no VOC concentrations in soil exceeding the NJDEP NRDCSCC.

Six of the eight sample locations containing total lead in concentrations above the NJDEP NRDCSCC (600 mg/kg) are in the northeastern corner of the Tank Basin 302, within 100 feet of Tank 302 (S2140, S2142, S2143, S2436, S2437, and S2441). The remaining two sample locations with total lead concentrations exceeding the NJDEP NRDCSCC (S2450 and S2554) are located off the northwest and southwest sides of Tank 302, within 25 feet of the tank, as depicted on Figure 5. In general, the field XRF data corresponds well to the analytical data collected at each soil boring location in NF3B, as depicted on Figure 5 and Figure 13. Figure 13 depicts soil boring/XRF screening locations with total lead concentrations exceeding 600 ppm to the north and west of Tank 302. Analytical soil data from these borings confirm concentrations of total lead exceeding the NJDEP NRDCSCC (600 mg/kg) to the north of Tank 302. No XRF measurements were conducted at location S2140; therefore, no lead exceedances are depicted in this area on Figure 13. However, the total lead concentration at S2140 (3,520 mg/kg) is above the

Table 11. AOI NF3B Soil Analytical Results

Sample ID	Sample Depth (ft. bgs.)	VOC Exceedances (mg/kg)	SVOC Exceedances (mg/kg)	Total Lead Exceedances (mg/kg)	TEL Values
S2140C3	5.0-5.5	NA	None	3,520	0.94U
S2140H4	15.5-16.0	None	None	None	0.08U
S2141B4	3.5-4.0	NA	NA	None	0.083U
S2141D1	6.0-6.5	NA	NA	None	0.076U
S2142B4	3.5-4.0	NA	NA	6,250	0.88U
S2142E2	8.5-9.0	NA	NA	None	0.091U
S2143B1	2.0-2.5	Benzene (1.9)*	NA	4,680	0.87U
S2143D2	6.5-7.0	Benzene (4.7)* Xylene (460)*	NA	None	0.38U
S2144B4	3.5-4.0	None	None	None	NA
S2144D2	6.5-7.0	None	None	None	NA
S2436D3	7.0-7.5	Benzene (5.7)* Ethylbenzene (170)* Xylene (710)*	NA	NA	NA
S2436E2	8.5-9.0	NA	NA	2,100	NA
S2436F3	11.0-11.5	NA	NA	None	NA
S2436G2	12.5-13.0	None	NA	NA	NA
S2437D3	7.0-7.5	NA	NA	781	NA
S2437G1	12.0-12.5	NA	NA	None	NA
S2437G2	12.5-13.0	NA	NA	None	NA
S2437H2	14.5-15.0	NA	NA	None	NA
S2438C1	4.0-4.5	None	NA	NA	NA
S2438D1	6.0-6.5	None	NA	NA	NA
S2439E1	8.0-8.5	None	NA	NA	NA
S2440B3	3.0-3.5	Xylene (88)*	NA	NA	NA
S2440D1	6.0-6.5	NA	NA	None	NA
S2440D2	6.5-7.0	None	NA	NA	NA
S2441B3	3.0-3.5	None	NA	NA	NA
S2441C1	4.0-4.5	NA	NA	2,150	NA
S2441C2	4.5-5.0	None	NA	NA	NA
S2441D3	7.0-7.5	NA	NA	None	NA
S2445B2	2.5-3.0	NA	NA	None	NA
S2445B3	3.0-3.5	None	NA	None	NA
S2445D4	7.5-8.0	Benzene (4.4)*	NA	NA	NA
S2445E1	8.0-8.5	NA	NA	None	NA
S2447D3	7.0-7.5	NA	NA	592*	NA
S2447F3	11.0-11.5	NA	NA	None	NA
S2449B4	3.5-4.0	NA	NA	None	NA
S2449D1	6.0-6.5	None	NA	NA	NA
S2449D3	7.0-7.5	Benzene (5.1)*	NA	NA	NA
S2449D4	7.5-8.0	NA	NA	None	NA

Table 11. AOI NF3B Soil Analytical Results

Sample ID	Sample Depth (ft. bgs.)	VOC Exceedances (mg/kg)	SVOC Exceedances (mg/kg)	Total Lead Exceedances (mg/kg)	TEL Values
S2450A4	1.5-2.0	NA	NA	1,940	NA
S2450B2	2.5-3.0	None	NA	NA	NA
S2450D1	6.0-6.5	None	NA	NA	NA
S2450E2	8.5-9.0	NA	NA	None	NA
S2552B2	2.5-3.0	NA	NA	466*	NA
S2552B3	3.0-3.5	None	NA	NA	NA
S2552C1	4.0-4.5	None	NA	NA	NA
S2552D4	7.5-8.0	NA	NA	None	NA
S2553A4	1.5-2.0	NA	NA	None	NA
S2553B2	2.5-3.0	None	NA	NA	NA
S2553B3	3.0-3.5	NA	NA	None	NA
S2553B4	3.5-4.0	None	NA	NA	NA
S2554B1	2.0-2.5	NA	NA	15,600	NA
S2554B3	3.0-3.5	None	NA	NA	NA
S2554D2	6.5-7.0	None	NA	NA	NA
S2554E1	8.0-8.5	NA	NA	None	NA
S2555B4	3.5-4.0	NA	NA	None	NA
S2555C1	4.0-4.5	None	NA	NA	NA
S2555D2	6.5-7.0	NA	NA	None	NA
S2555D4	7.5-8.0	None	NA	NA	NA
S2556B3	3.0-3.5	NA	NA	None	NA
S2556C4	5.5-6.0	NA	NA	None	NA
S2557A3	1.0-1.5	NA	NA	None	NA
S2557B1	2.0-2.5	Benzene (4.3)* Xylene (70)*	NA	NA	NA
S2557D2	6.5-7.0	NA	NA	None	NA
S2557D4	7.5-8.0	None	NA	NA	NA

NA = Not Analyzed.

*Exceeds SRFI Evaluation Criteria only; does not exceed NJDEP NRDCSCC.

NJDEP NRDCSCC. In contrast, Figure 13 depicts XRF lead measurements of over 600 ppm at soil borings S2438, S2439, S2440, S2446, S2447, and S2552; whereas analytical data indicate maximum total lead concentrations below 600 mg/kg at these locations. Each endpoint sample analyzed for lead in NF3B yielded concentrations of lead below the NJDEP NRDCSCC. This data, coupled with historical soil data across this area, demonstrate horizontal and vertical delineation of lead contamination across NF3B. Cross sections depicted on Figure 13 and Figure 13A bisect each lead contaminated zone in this area, and graphically depict the complete horizontal and vertical extent of lead contamination.

5.1.4 AOI NF5

SRFI investigation activities conducted across the NF5 vicinity included 12 soil borings, 10 MIP points, one permanent shallow groundwater monitoring well, and two permanent dual-cased deep groundwater monitoring wells. All were installed using the decision-based sampling and analysis strategy as detailed in the October 2006 SRFI DWP. This soil and groundwater investigation was conducted to further delineate COCs across the NF5 area. Table 12 summarizes the 11 soil borings advanced in NF5 during the SRFI.

Table 12. AOI NF5 SRFI Soil Borings

Boring ID	Well ID	Work Plan ID	Parameter(s)	Sample Depths (ft. bgs)	
S2090	N/A	MW-136D	VOCs, SVOCs, Metals	17.5-18.0	24.5-25.0
			VOCs	7.5-8.0	
S2091	N/A	NF5PB6	VOCs, As, Pb	9.0-9.5	12.5-13.0
				19.5-20.0	
S2093	N/A	MW-0032D	VOCs, SVOCs, Metals	9.5-10.0	17.5-18.0
S2097	N/A	NF5PB7	VOCs, As, Pb	12.0-12.5	17.5-18.0
S2123	MW-241	S0988S	VOCs, Metals	9.0-9.5	14.0-14.5
S2127	N/A	NF5PB5	VOCs, As, Pb	6.5-7.0	9.5-10.0
S2128	N/A	NF5PB1	VOCs, As, Pb	4.5-5.0	7.5-8.0
S2129	MW-238	MW-117D	None	None	
S2132	N/A	NF5PB2	VOCs, As, Pb	3.5-4.0	9.0-9.5
S2133	N/A	NF5PB3	VOCs, As, Pb	3.0-3.5	7.0-7.5
S2134	N/A	NF5PB4	VOCs, SVOCs, As, Pb	2.5-3.0	15.5-16.0
S2442	N/A	NA	Pb	14.0-14.5	16.0-16.5

N/A = Not Applicable

Two soil samples were collected at each boring location as specified in the NF/MY SRFI DWP, with the exception of soil borings S2090, S2091, and S2127, where three soil samples were collected. The first soil sample was typically collected from the shallow, fill material, in the core interval exhibiting the greatest potential for petroleum hydrocarbon impacted soil based upon visual, olfactory, and PID response. The second sample was collected from the first core interval exhibiting no potential for petroleum hydrocarbon impacted soil, based upon visual, olfactory, and PID response. Soil samples were then transferred into appropriate laboratory cleaned sample containers and placed in a cooler with ice for laboratory submittal.

A total of 24 (plus one duplicate) soil samples were collected from 11 of the 12 soil borings advanced in NF5 vicinity. Analytical parameters included TCL VOCs +10 (EPA Method SW-846 8260B), TCL SVOCs +20 (EPA Method SW-846 8270C), TAL metals (EPA Method SW-846 6010B), and soil moisture (EPA 160.3).

NF5 Lithology and OVM Observations

The lithology within NF5 is characterized in general by the following stratigraphic progression from ground surface to boring termination; gray/brown silt/silty sand and gravel (0 to 4.0 ft. bgs), brown silty sand (4.0 to 10.0 ft. bgs), and/or black fine to coarse silty sand (4.0 to 14.0 ft. bgs) with petroleum staining and petroleum odor, gray silt and silty sand (12.0 to 15.0 ft. bgs), brown gray peat underlain by gray silty clay with root fragments (Clay Horizon A) (6.0 to 20.0 ft. bgs), and red brown silt and silty clay with gravel (13.0 to 25.0 ft. bgs). Clay Horizon A is encountered in every boring location across NF5 with the exception of S2097, at an average depth of 9.0 ft. bgs. The peat layer of Clay Horizon A is generally overlain by a fine to coarse black sand/silty sand horizon that is discontinuous across the area, but is found at shallow depths in the southeastern portion of NF5 (S2127, S2129, and S2134). Petroleum staining and odor is usually associated with this black sand. The peat portion of Clay Horizon A is underlain by a gray organic clay horizon. In two of the NF5 borings (S2129 and S2134) and in one adjacent NF3A boring (S2090), a red brown silty sand/clayey sand was encountered beneath Clay Horizon A. This material is part of a native, discontinuous till horizon. OVM readings across the area were generally between 0 to less than 100 ppm, with the highest reading (739 ppm) identified in S2127 at a depth of 6.5 to 7.0 ft. bgs (see Figure 15). This reading was observed in black coarse sand with petroleum staining and strong petroleum odor. Only 2.5 feet below this interval, OVM readings dropped to 14.1 ppm at a depth of 9.5 to 10.0 ft. bgs, within the peat horizon.

Ten MIP points were collected within NF5 at borings S2090 through S2099. These ten MIP points were used to optimize the screen placement of SRFI shallow and deep wells along Woodbridge Creek. The findings of these MIP points are discussed in Section 5.5.

NF5 Soil Analytical Results

Of the 19 soil samples collected and analyzed for VOCs, only one sample (S2128C2) contained benzene (39 mg/kg) at a concentration exceeding the NJDEP NRDCSCC (13 mg/kg). Sample S2128C2 was collected between 4.5 to 5.0 ft. bgs, from a black fine to coarse sand with petroleum staining and a strong petroleum odor. An OVM reading of 209 ppm was measured at this interval. A second sample (S2128D4) was collected 2.5 feet below the first interval, between 7.5 to 8.0 ft. bgs. This sample was collected at the top of Clay Horizon A, from gray silt with no petroleum odor or staining, and contained no VOCs in excess of the NJDEP NRDCSCC. An OVM reading of 8.4 ppm was measured at this interval. No other soil samples collected in the NF5 vicinity contained concentrations of VOCs in excess of the NJDEP NRDCSCC. Soil samples from four boring locations in this area (S2127, S2128, S2133, and S2134) contained concentrations of VOCs in excess of the SRFI Evaluation Criteria only. Table 13 and Appendix D summarize soil analytical data for the NF5 Area.

The benzene concentration exceeding the NJDEP NRDCSCC at soil boring S2128 (39 mg/kg) is depicted on Figure 16 as an area of benzene greater than 13 ppm. Figure 15 depicts OVM readings greater than 100 ppm at S2128. Immediately adjacent to the south

Table 13. AOI NF5 Soil Analytical Results

Sample ID	Sample Depth (ft. bgs)	VOC Exceedances (mg/kg)	SVOC Exceedances (mg/kg)	Metals Exceedances (mg/kg)
S2090D4	7.5-8.0	None	Not Analyzed	Not Analyzed
S2090I4	17.5-18.0	None	None	None
S2090M2	24.5-25.0	None	None	None
S2091E3	9.0-9.5	None	NA	None
S2091G2	12.5-13.0	None	NA	None
S2091J4	19.5-20.0	None	NA	None
S2093E4	9.5-10.0	None	Benzo(a)anthracene (3.5J)* Benzo(a)pyrene (2.9J) Benzo(b)fluoranthene (4.6J)	None
S2093I4	17.5-18.0	None	None	Fe (44,000)*
S2097G1	12.0-12.5	None	NA	As (25.7)
S2097I4	14.0-14.5	None	NA	None
S2123E3	9.0-9.5	None	None	None
S2123H1	14.0-14.5	None	None	Fe (27,300)*
S2127D2	6.5-7.0	Benzene (8.2)* Xylene (120)*	NA	As (37) Pb (439)*
S2127E4	9.5-10.0	Benzene (6.8)*	NA	None
S2128C2	4.5-5.0	Benzene (39) Cyclohexane (150)*	NA	Pb (1,910)
S2128D4	7.5-8.0	None	NA	None
S2132B4	3.5-4.0	None	NA	As (26.6)
S2132E3	9.0-9.5	None	NA	None
S2133B3	3.0-3.5	Benzene (4.5)*	NA	None
S2133D3	7.0-7.5	None	NA	None
S2134B2	2.5-3.0	Benzene (4.5)*	None	As (67.0) Pb (466)*

Table 13. AOI NF5 Soil Analytical Results

Sample ID	Sample Depth (ft. bgs)	VOC Exceedances (mg/kg)	SVOC Exceedances (mg/kg)	Metals Exceedances (mg/kg)
S2134H4	15.5-16.0	None	None	None
S2442H1	14.0-14.5	NA	NA	Pb (410)*
S2442I4	17.5-18.0	NA	NA	None

*Exceeds RFI Evaluation Criteria only, does not exceed NJDEP NRDCSCC.

NA = Not Analyzed

and southeast of S2128 is a large area of OVM readings greater than 316 ppm extending between MW-238 and S2127. No new areas with benzene concentrations greater than 13 ppm were identified in NF5; however the locations of historical benzene exceedances are depicted on Figure 16 and correlate well with the OVM model. An OVM reading of 734 ppm in soil boring S2127 verifies the lateral extent of OVM readings greater than 316 ppm as depicted by the OVM model in this area. The advancement of soil borings S2132, S2133, S2134, and S2442 constrained the OVM model to the southwest of MW-238, in the Tank 326 vicinity, when compared with the historical OVM model of the area (Figure 17). Figure 16 depicts a large area of benzene concentrations greater than 1 ppm encompassing most of the area bordered by Tanks 305, 306, 326, and 327. The model of OVM data presented on Figure 15 correlates well with the benzene model, and depicts OVM readings greater than 100 ppm over the central portion of this area, based on SRFI and historical data. Soil borings and corresponding MIP locations S2091, S2092, S2093, S2094, S2095, S2096, S2097, and S2098 were conducted along Woodbridge Creek at the northeastern edge of NF5, and contained no OVM readings greater than 100 ppm, and no benzene concentrations in soil greater than 13 ppm.

Data collected during the SRFI has contributed significantly to the vertical and horizontal delineation using three-dimensional modeling of the area, which is evident when comparing historical cross sections with cross sections generated after the SRFI (see Figure 15 and Figure 15A). During Chevron's analysis of all NF5 historical soil data, it was evident that horizontal and vertical delineation of VOCs in soil had not been achieved as seen in the historical cross sections shown on Figure 15A. However, this analysis did indicate the location of data gaps to be studied during the SRFI soil investigation conducted in 2006. As such, soil samples collected during the SRFI enabled Chevron to complete the horizontal and vertical delineation of VOCs across NF5 as depicted on SRFI cross sections on Figure 15A, which included data from both the SRFI and historical soil data.

Only one soil sample (S2093E4) of the six soil samples collected and analyzed for SVOCs in the NF5 area contained laboratory estimated concentrations of SVOCs (benzo(a)pyrene at 2.9J mg/kg, and benzo(b)fluoranthene at 4.6J mg/kg) in excess of the NJDEP NRDCSCC (0.66 mg/kg and 4 mg/kg, respectively). This sample also contained the SVOC benzo(a)anthracene (3.5J mg/kg) in a concentration exceeding the SRFI Evaluation Criteria (0.9 mg/kg). A second sample collected from the same boring (S2093I4) between 17.5 to 18.0 ft. bgs contained no SVOCs in excess of the NJDEP NRDCSCC or SRFI Evaluation Criteria. In addition, no other SVOCs were detected in concentrations exceeding the NJDEP NRDCSCC or SRFI Evaluation Criteria in NF5. The SVOC exceedance of benzo(a)pyrene at S2093 appears to be isolated, as benzo(a)pyrene was not detected in historical soil boring S0800, immediately upgradient and adjacent to S2093. Soil borings S2123 and S2134 delineate the occurrence of benzo(a)pyrene in this area, which extends between Tanks 326 and 328, and southwest along Flare Street, as depicted in Figure 7.

A total of 21 soil samples collected from the NF5 Area were collected and analyzed for metals in the NF5 Area. Four samples (S2097G1, S2127D2, S2132E3, and S2134B2)

contained concentrations of arsenic exceeding the NJDEP NRDCSCC. Each of these samples was collected from a black silt or sand with petroleum odor and staining (S2132 was collected from a tar-like material), and was determined to be fill material at the fill/native interface. Endpoint samples at each of these sampling locations were collected from native material beneath the fill (Clay Horizon A), and yielded concentrations of total arsenic below the NJDEP NRDCSCC. Figure 6 shows the distribution of SRFI and historical arsenic sampling locations across NF5. Based upon three-dimensional modeling of arsenic across NF5, arsenic appears in isolated pockets of relatively small aerial extent.

One sample (S2128C2) collected between 4.5 to 5.0 ft. bgs contained lead (1,910 mg/kg) at a concentration exceeding the NJDEP NRDCSCC (600 mg/kg). An endpoint sample collected at this location (S2128D4) between 7.5 to 8.0 ft. bgs contained no lead in excess of the NJDEP NRDCSCC. Figure 5 depicts the distribution of historical and SRFI soil borings containing lead in concentrations exceeding the NJDEP NRDCSCC. This figure depicts a semi-linear pattern of borings with lead exceedances extending from Tank T-9200 southward, towards Barber Street, with a majority of the borings located along the eastern sides of the 326 and 327 Tank Basins.

5.1.5 AOI NF6

SRFI investigation activities conducted across the NF6 vicinity included 12 soil borings, one MIP point, one permanent shallow groundwater monitoring well, and two permanent dual-cased groundwater monitoring wells, installed using the decision-based sampling and analysis strategy as detailed in the October 2006 SRFI DWP. This soil and groundwater investigation was conducted to further delineate COCs across the NF6 Area. Table 14 summarizes the 12 soil borings advanced in NF6 during the SRFI.

Table 14. NF6 SRFI Soil Borings

Boring ID	Well ID	Work Plan ID	Parameter(s)	Sample Depths (ft. bgs)	
S2100	N/A	NF6PB5	VOCs, Metals	13.5-14.0	20.0-20.5
S2108	MW-243, MW-244	S1009S, S1009D	VOCs, Metals	3.5-4.0	24.5-25.0
S2113	N/A	NF6PB1	VOCs, SVOCs, Metals	8.0-8.5	17.5-18.0
S2114	N/A	NF6PB10	VOCs, SVOCs, Metals	9.5-10.0	19.0-19.5
S2115	N/A	NF6PB4	VOCs, SVOCs, Metals	15.5-16.0	19.0-19.5
S2116	MW-239	RW-42D	VOCs, SVOCs, Metals	8.5-9.0	19.0-19.5
S2117	N/A	NF6PB9	VOCs, SVOCs, Metals	9.0-9.5	19.0-19.5
S2120	N/A	NF6PB3	VOCs, SVOCs, Metals	9.0-9.5	14.5-15.0
S2121	N/A	NF6PB2	VOCs, SVOCs, Metals	3.5-4.0	14.5-15.0
S2122	N/A	NA	VOCs, SVOCs, Metals	18.0-18.5	19.0-19.5
S2125	N/A	NF6PB7	VOCs, SVOCs, Metals	11.5-12.0	19.5-20.0
S2126	N/A	NF6PB6	VOCs, SVOCs, Metals	8.0-8.5	14.5-15.0

N/A = Not Applicable

Two soil samples were collected at each boring location as specified in the NF/MY SRFI DWP. The first soil sample was typically collected from the shallow, fill material, in the core interval exhibiting the greatest potential for petroleum hydrocarbon impacted soil based upon visual, olfactory, and PID response. The second sample was collected from the next deeper core interval exhibiting no potential for petroleum hydrocarbon impacted soil, based upon visual, olfactory, and PID response. Soil samples were then transferred into appropriate laboratory cleaned sample containers and placed in a cooler with ice for laboratory submittal.

A total of 24 (and two duplicate) soil samples were collected from the 12 soil borings advanced in NF6 vicinity. Analytical parameters included TCL VOCs +10 (EPA Method SW-846 8260B), TCL SVOCs +20 (EPA Method SW-846 8270C), TAL metals (EPA Method SW-846 6010B), and soil moisture (EPA 160.3).

NF6 Lithology and OVM Observations

The lithology within NF6 is characterized in general by the following stratigraphic progression from ground surface to boring termination; red brown/brown silt/silty clay and gravel (0 to 10.0 ft. bgs), gray/brown silty sand (4.0 to 10.0 ft. bgs) and/or black fine to coarse silty sand (3.0 to 17.0 ft. bgs) with petroleum staining and petroleum odor, gray silt and silty sand (10.0 to 18.0 ft. bgs), brown gray peat underlain by gray silty clay with root fragments (Clay Horizon A) (9.0 to 20.0 ft. bgs), and red brown silt and silty clay with gravel (18.0 to 20.0 ft. bgs). Clay Horizon A is encountered in every boring location across NF6 with the exception of borings S2121 and S2122, at an average depth of 11.0 ft. bgs. The peat horizon is generally overlain by a fine to coarse black sand/silty sand horizon that is discontinuous across the area, typically encountered between 3.0 to 9.0 ft. bgs, and between three to eight feet thick. Petroleum staining and odor are usually associated with this black sand. Clay Horizon A consists of a peat, underlain by a gray organic clay horizon in this vicinity. Till was encountered in five of the NF6 boring locations between 18.0 to 20.0 ft. bgs (S2113, S2114, S2115, S2116, and S2121). OVM readings in each boring across NF6 generally ranged between 0 to less than 400 ppm, with the highest reading (1,241 ppm) identified in S2113 at a depth of 8.0 to 8.5 ft. bgs (see Figure 15). This reading was observed in a black fine to coarse sand (possibly fly ash) with heavy petroleum staining and strong petroleum odor. Approximately nine feet below this interval, OVM readings dropped to 25.8 ppm at a depth of 17.0 to 17.5 ft. bgs within gray silt, immediately below the peat horizon.

One MIP point was collected within NF6 at boring S2100 to verify the three-dimensional visualization computer model of NF6 and to verify the sampling strategy. The findings of this MIP point are discussed in Section 5.5.

NF6 Soil Analytical Results

A summary of SRFI soil analytical data for the NF6 Area is presented in Table 15 and Appendix D.

NF6 Volatile Organic Compounds

Of the 24 soil samples collected and analyzed for VOCs, only four samples (S2100G4, S2113E1, S2116E2, and S2125F4) contained benzene in concentrations exceeding the NJDEP NRDCSCC (13 mg/kg) (see Figure 16). The following is a discussion of the four boring locations with soil benzene concentrations exceeding the NJDEP NRDCSCC as presented in Table 15.

Sample S2100G4 was collected between 13.5 to 14.0 ft. bgs, from the top of a dark brown peat representing the Clay Horizon A interface, and had a slight petroleum odor. This sample contained benzene (16 mg/kg) at a concentration exceeding the NJDEP NRDCSCC. An OVM reading of 36.5 ppm was measured at this interval. A second sample (S2100K1) was collected six feet below the first interval, between 20.0 to 20.5 ft. bgs. This sample was collected within Clay Horizon A, from gray clay with no petroleum odor or staining, and contained no VOCs in concentrations exceeding the NJDEP NRDCSCC. An OVM reading of 0.4 ppm was measured at this interval.

Sample S2113E1 was collected between 8.0 to 8.5 ft. bgs, from a black flyash and/or sand with heavy petroleum staining and odor. This sample contained benzene (520 mg/kg) at a concentration exceeding the NJDEP NRDCSCC. The highest OVM reading within NF6 (1,241 ppm) was measured at this interval, as mentioned above. A second sample (S2113J4) was collected 11 feet below the first interval, between 19.5 to 20.0 ft. bgs. This sample was collected within the till, beneath Clay Horizon A, from red brown fine sand with no petroleum staining or odor. This sample contained no VOCs in concentrations exceeding the NJDEP NRDCSCC. An OVM reading of 6.8 ppm was measured at this interval.

Sample S2116E2 was collected between 8.5 to 9.0 ft. bgs, from a black fine to coarse sand with heavy petroleum staining and odor. This sample contained benzene (94 mg/kg) at a concentration exceeding the NJDEP NRDCSCC. An OVM reading of 936 ppm was measured at this interval. A second sample (S2116J3) was collected 10 feet below the first interval, between 19.0 to 19.5 ft. bgs. This sample was collected within Clay Horizon A, from gray silty clay with no petroleum staining or odor. This sample contained no VOCs in concentrations exceeding the NJDEP NRDCSCC, and an OVM reading of 3.3 ppm was measured at this interval.

Sample S2125F4 was collected between 11.5 to 12.0 ft. bgs, from the top of a dark brown peat representing the Clay Horizon A interface, with heavy petroleum staining and odor. This sample contained benzene (24 mg/kg) in a concentration exceeding the NJDEP NRDCSCC. An OVM reading of 326 ppm was measured at this interval. A second sample (S2125J4) was collected 7.5 feet below the first interval, between 19.5 to 20.0 ft. bgs. This sample was collected within the till, beneath Clay Horizon A, from red brown clayey silt, with no petroleum staining or odor. This sample contained no VOCs in concentrations exceeding the NJDEP NRDCSCC, and yielded an OVM reading of 12.5 ppm.

Table 15. AOI NF6 Soil Analytical Results

Sample ID	Sample Depth (ft. bgs.)	VOC Exceedances (mg/kg)	SVOC Exceedances (mg/kg)	Metals Exceedances (mg/kg)
S2100G4	13.5-14.0	Benzene (16) Methylcyclohexane (51)*	NA	Fe (32,500)*
S2100K1	20.0-20.5	None	NA	None
S2108B4	3.5-4.0	None	NA	Fe (39,400)*
S2108M2	24.5-25.0	None	NA	Fe (43,500)*
S2113E1	8.0-8.5	Benzene (520) Xylene (460)*	None	None
S2113J4	17.5-18.0	Benzene (1.3)*	None	None
S2114E4	9.5-10.0	Benzene (3.0)*	None	Fe (35,600)*
S2114J3	19.0-19.5	None	None	Fe (34,700)*
S2115H4	15.5-16.0	None	None	None
S2115J3	19.0-19.5	None	None	Fe (28,900)*
S2116E2	8.5-9.0	Benzene (94) Xylene (91)*	Benzo(a)anthracene (2.8J)*	None
S2116J3	19.0-19.5	None	None	Fe (30,200)*
S2117E3	9.0-9.5	Benzene (6.4)* Cyclohexane (170)	None	Fe (25,800)*
S2117J3	19.0-19.5	None	None	None
S2120E3	9.0-9.5	None	Acetophenone (2.8)* N-Nitroso-di-n-propylamine (5.9)	None
S2120H2	14.5-15.0	None	None	None
S2121B4	3.0-3.5	None	None	None
S2121H2	7.0-7.5	None	None	None
S2122J1	18.0-18.5	Benzene (1.2)*	None	None
S2122J3	19.0-19.5	None	None	None
S2125F4	11.5-12.0	Benzene (24)	None	None

Table 15. AOI NF6 Soil Analytical Results

Sample ID	Sample Depth (ft. bgs.)	VOC Exceedances (mg/kg)	SVOC Exceedances (mg/kg)	Metals Exceedances (mg/kg)
S2125J4	19.5-20.0	None	None	Fe (25,500)*
S2126E1	8.0-8.5	None	None	None
S2126H2	14.5-15.0	None	None	None

*Exceeds SRFI Evaluation Criteria only, does not exceed NJDEP NRDCSCC.

NA = Not Analyzed.

Seven soil samples (S2100G4, S2113E1, S2113J4, S2114E4, S2116E2, S2117E3, and S2122J1) contained concentrations of VOCs in excess of the SRFI Evaluation Criteria only.

Data collected during the SRFI has contributed significantly to vertical and horizontal delineation using three-dimensional modeling of the area, which is evident when comparing historical cross sections with cross sections generated after the SRFI (see Figure 15 and Figure 15A). During Chevron's analysis of all NF5 and NF6 historical soil data, it was evident that horizontal and vertical delineation of VOCs in soil had not been achieved as seen in the historical cross sections shown on Figure 15A. However, this analysis did indicate the location of data gaps to be studied during the SRFI soil investigation conducted in 2006. As such, soil samples collected during the SRFI enabled Chevron to complete the horizontal and vertical delineation of VOCs across NF6 as depicted on SRFI cross sections on Figure 15A, which included data from both the SRFI and historical soil data.

The vertical delineation of contamination achieved in each of the SRFI borings across NF6 has contributed significantly to vertical and horizontal delineation of the OVM and benzene in the NF6 Area. This control is evident when comparing historical OVM data cross sections with cross sections generated after the SRFI (see Figure 15 and Figure 15A). OVM readings greater than 316 ppm in soil borings S2113, S2116, and S2117 verify the lateral extent of high OVM readings across the lower portion of NF6 between Flare and Barber Streets as depicted on Figure 15. However, the extent of high OVM readings on the vertical and horizontal axes is significantly reduced in the vicinity of S2113 and S2117 when AOI NF6 cross section b-b' is compared against historical AOI NF6 cross section B-B'. Figure 16 depicts each of the four SRFI boring locations with benzene concentrations exceeding the NJDEP NRDCSCC as areas of benzene greater than 13 mg/kg. The new SRFI soil boring data have been incorporated into the model along with historical soil boring data to help delineate the vertical and horizontal distribution of benzene. This distribution correlates well with the OVM model for the NF6 Area. Areas of benzene greater than 13 ppm are found within larger plumes of benzene greater than 1 ppm. In addition, these benzene plumes are generally located on the downgradient end of LNAPL plumes depicted on Figure 16.

NF6 Semi-Volatile Compounds

As shown in Table 15, only one of the 20 soil samples (S2120E3) collected and analyzed for SVOCs in the NF6 area contained an SVOC (N-nitroso-di-n-propylamine at 5.9 mg/kg) at a concentration exceeding the NJDEP NRDCSCC (0.66 mg/kg). This sample was collected between 9.0 to 9.5 ft. bgs, from black coarse sand with petroleum odor and staining. An OVM reading of 200 ppm was measured at this interval. A second sample collected from this boring (S2120H2) between 14.5 to 15.0 ft. bgs contained no SVOCs in excess of the NJDEP NRDCSCC. This sample was collected from a brown peat at the Clay Horizon A interface. An OVM reading of 4.6 ppm was measured at this interval. The SVOC exceedance of N-nitroso-di-n-propylamine at S2120 appears to be isolated, or of very limited aerial extent, as N-nitroso-di-n-propylamine was not detected in any other

SRFI or historical soil borings in this vicinity. The occurrence of benzo(a)pyrene in soil across NF6 is minimal (see Figure 7).

NF6 Metals

All 24 soil samples collected from the NF6 Area were analyzed for metals. No metals except iron were detected in concentrations exceeding the NJDEP NRDCSCC. Iron was detected in concentrations above the SRFI Evaluation Criteria in seven of the NF6 boring locations as presented in Table 15.

5.2 SRFI Soil Findings – East Yard

During the SRFI, 55 soil borings were advanced in the EY (see Figure 18). Based on the data from these SRFI soil borings and historical soil borings, three yard-wide maps were created of the entire EY depicting OVM readings, total lead, and total arsenic concentrations in soil (see Figure 19 through Figure 21). Yard-wide contaminant distribution maps were limited to lead and arsenic based on their frequency of exceedances. The distribution of benzene in soil is presented in this section as individual AOI scale drawings and cross sections. Figure 7 depicts the distribution of benzo(a)pyrene in soil on a site-wide scale. These COCs were chosen for illustration based on their occurrence across the site and their risk to human health. In addition, these compounds have historically been primary indicators for other contaminants (e.g., xylene, benzo(a)anthracene, etc.) present in the soil. Appendix D contains all the analytical soil data collected during the SRFI.

5.2.1 AOI 1

SRFI investigative work was conducted across AOI 1 and its vicinity (including AOCs 27 and 37, PAOCs 70 and 72, and SWMUs 10 and 42). During the SRFI, a total of 18 soil borings, seven temporary shallow groundwater monitoring wells, and five permanent groundwater monitoring wells were installed in the AOI 1 Area using the decision-based sampling and analysis strategy as detailed in the December 2006 SRFI DWP. This soil and groundwater investigation was conducted to further delineate COCs across AOI 1 and the vicinity. Table 16 summarizes the 18 soil borings advanced in AOI 1 during the SRFI.

In the AOI 1 vicinity, two soil samples were typically collected at each boring location; however the actual number of samples collected at each location was dependent upon the Sampling and Analysis Strategy detailed in the EY SRFI DWP. Additional core intervals were sampled on occasion where potential petroleum impacts to soil were identified. The first soil sample was taken in the core interval exhibiting the greatest potential for petroleum hydrocarbon impacted soil based upon visual, olfactory, and PID response. This typically occurred in the shallow fill material. A second sample was collected from the next deeper core interval exhibiting no potential for petroleum hydrocarbon impacted soil based upon visual, olfactory, and PID response. Soil samples were then transferred

Table 16. AOI 1 SRFI Soil Borings

Boring ID	Work Plan ID	Parameter(s)	Sample Depths (ft. bgs)	
S2292	H0998	VOCs	3.0-3.5	4.5-5.0
S2293	H0999	VOCs	3.5-4.0	6.0-6.5
			9.0-9.5	
S2294	H1000	VOCs	4.0-4.5	6.5-7.0
S2295	S2295	VOCs	10.5-11.0	
S2296	S2296	VOCs	11.0-11.5	13.0-13.5
S2298	S2298	VOCs	10.5-11.0	13.5-14.0
S2299	S2299	VOCs	8.5-9.0	10.5-11.0
S2300	S2300	VOCs	4.5-5.0	5.5-6.0
S2301	S2301	VOCs	4.5-5.0	7.5-8.0
S2303	S2303	VOCs	10.5-11.0	14.5-15.0
S2304	S2304	VOCs	3.0-3.5	9.5-10.0
S2306	MW-235	NA	NA	
S2307	MW-236	VOCs	9.0-9.5	4.0-4.5
S2308	MW-245	VOCs	6.0-6.5	7.5-8.0
S2309	MW-246	NA	NA	
S2310	MW-247	VOCs	7.5-8.0	10.0-10.5
S2362	S2362	VOCs	4.0-4.5	14.5-15.0
S2363	S2363	VOCs	3.5-4.0	7.5-8.0

NA = Not Analyzed

into appropriate laboratory cleaned sample containers and placed in a cooler with ice for laboratory submittal.

A total of 32 soil samples were collected from 16 of the 21 soil borings advanced in the AOI 1 vicinity. Each of these samples was analyzed for TCL VOCs +10 (EPA Method SW-846 8260B) and soil moisture (EPA 160.3).

AOI 1 Lithology and OVM Observations

The lithology within AOI 1 is characterized in general by the following stratigraphic progression from ground surface to boring termination; red brown silt (0 to 3.0 ft. bgs), black sand/sandy silt (3.0 to 5.0 ft. bgs), gray fine to coarse sand (5.0 to 7.0 ft. bgs), black peat underlain by dark to olive gray silt (Clay Horizon A) (7.0 to 12.0 ft. bgs), and olive brown to red brown silt and silty clay (12.0 to 16.0 ft. bgs). Although discontinuous across the area, the peat is generally encountered at greater depth in an easterly direction (11.0 to 14.0 ft. bgs), as observed on AOI 1 cross-sections (see Figure 22 and Figure 22A). The peat horizon is generally overlain by a fine to coarse black sand horizon that is discontinuous across the area, but is found at greater depths in an easterly direction (7.0 to 9.0 ft. bgs). Petroleum staining and odor is occasionally associated with this black sand.

OVM readings across the area were generally between 0 to 300 ppm, with the highest reading (2,009 ppm) identified in S2298 at a depth of 10.5 to 11.0 ft. bgs on the western side of Tank 777 Basin (Figure 22). Only 2.5 feet below this interval, OVM readings dropped to 0 ppm at a depth of 13.5 to 14.0 ft. bgs. Soil boring S2296 was advanced approximately 80 feet east of S2298 in Tank 777 Basin. An OVM reading of 1,666 ppm was observed at a depth of 11.0 to 11.5 ft. bgs. The high OVM readings between the 10.5 and 11.5 foot depth between these two borings are likely associated with one another, as indicated on Figure 22A. Historical borings located approximately 120 feet northwest (S0961) and 120 feet south (S1410) of S2298 yielded OVM readings in excess of 300 ppm during previous site work. The SRFI soil borings S2296 and S2298 further delineate the OVM data model for this area. New SRFI soil borings (S2300, S2301, S2302, S2303, S2307, and S2308) advanced to the south and east of Tank 777, also further constrain the OVM data model for this area. In particular, the extent of high OVM readings surrounding historical temporary well locations HP-0044 and HP-0059 was constrained by OVM data from the new soil boring S2308.

AOI 1 Soil Analytical Results

Of the 32 soil samples collected within AOI 1, only three samples (S2294C1, S2296F3, and S2298F2) contained concentrations of VOCs in excess of the NJDEP NRDCSCC. Table 17 summarizes the soil analytical results at AOI 1.

Sample SS2294C1 was collected between 4.0 to 4.5 ft. bgs, and contained benzene (56 mg/kg) in excess of the NJDEP NRDCSCC (13 mg/kg). This sample location is approximately 170 feet west of Tank 777, outside of the tank basin, as depicted on Figure 23. Interestingly, there were no OVM readings over 100 ppm associated with this location, as depicted on Figure 22.

Sample SS2296F3 was collected between 11.0 to 11.5 ft. bgs, and contained benzene (49 mg/kg) in excess of the NJDEP NRDCSCC (13 mg/kg). Sample S2298F2 was collected from the 10.5 to 11.0 ft. bgs interval and contained benzene (170 mg/kg) and total xylene (2,000 mg/kg) in excess of the NJDEP NRDCSCC (13 mg/kg and 1,000 mg/kg, respectively). These two locations are approximately 80 feet apart, on the west side of Tank 777. Based upon the data model, benzene between these two locations appears to be correlated (Figure 23). In addition, OVM readings over 300 ppm correlate with these benzene detections as depicted on Figure 22.

No benzene was detected in concentrations above 1 ppm at any of the locations south and east of Tank 777 that had OVM readings over 300 ppm. No OVM readings greater than 100 ppm were observed in soil boring S2303; however, benzene was detected in a concentration of 5 mg/kg between 10.5 to 11.0 ft. bgs. Across the AOI 1 Area, endpoint samples were collected between depths of 6.0 to 14.5 ft. bgs. None of the endpoint samples in this area contained concentrations of VOCs in excess of the NJDEP NRDCSCC.

Table 17. AOI 1 Soil Analytical Results

Sample ID	Sample Depth (ft. bgs)	VOC Exceedances (mg/kg)
S2292B3	3.0-3.5	None
S2292C2	4.5-5.0	None
S2293B4	3.5-4.0	Benzene (1.1)*
S2293D1	6.0-6.5	None
S2293E3	9.0-9.5	None
S2294C1	4.0-4.5	Benzene (56) Ethylbenzene (120)* Xylene (690)*
S2294D2	6.5-7.0	None
S2295F2	10.5-11.0	None
S2296F3	11.0-11.5	Benzene (49) Ethylbenzene (480)* Xylene (280)*
S2296G3	13.0-13.5	None
S2298F2	10.5-11.0	Benzene (170) Ethylbenzene (590)* Xylene (2,000)
S2298G4	13.5-14.0	None
S2299E2	8.5-9.0	None
S2299F2	10.5-11.0	Benzene (1.5)*
S2300C2	4.5-5.0	None
S2300C4	5.5-6.0	None
S2301C2	4.5-5.0	None
S2301D4	7.5-8.0	None
S2303F2	10.5-11.0	Benzene (5)*
S2303H2	14.5-15.0	None
S2304B3	3.0-3.5	Xylene (610)*
S2304E4	9.5-10.0	None
S2307E3	9.0-9.5	None
S2307C1	4.0-4.5	None
S2308D1	6.0-6.5	None
S2308D4	7.5-8.0	None
S2310D4	7.5-8.0	None
S2310F1	10.0-10.5	None
S2362C1	4.0-4.5	None
S2362H2	14.5-15.0	None
S2363B4	3.5-4.0	None
S2363D4	7.5-8.0	None

*Exceeds RFI Evaluation Criteria only, does not exceed NJDEP NRDCSCC.

Data collected during the SRFI has contributed significantly to vertical and horizontal delineation using three-dimensional modeling of the area, which is evident when comparing historical cross sections with cross sections generated after the SRFI (see Figure 22 and Figure 22A). During Chevron's analysis of AOI 1 historical soil data, it was evident that horizontal and vertical delineation of VOCs in soil had not been achieved as seen in the historical cross sections shown on Figure 22A. However, this analysis did indicate the location of data gaps to be studied during the SRFI soil investigation conducted in 2006. As such, soil samples collected during the SRFI enabled Chevron to complete the horizontal and vertical delineation of VOCs across AOI 1 as depicted on SRFI cross sections on Figure 22A, which included data from both the SRFI and historical soil data.

5.2.2 AOI 2

SRFI investigative work was conducted across AOI 2 and its vicinity (including AOCs 14 and 26, and SWMUs 26, 36, and 45). During the SRFI, a total of 15 soil borings, one temporary shallow groundwater monitoring well, and three permanent groundwater monitoring wells were installed in the AOI 2 Area using the decision-based sampling and analysis strategy as detailed in the December 2006 SRFI DWP. This soil and groundwater investigation was conducted to further delineate COCs across AOI 2 and vicinity. Table 18 summarizes the 15 soil borings advanced in AOI 2 during the SRFI.

Table 18. AOI 2 SRFI Soil Borings

Boring ID	Work Plan ID	Parameter(s)	Sample Depths (ft. bgs)	
S2305	H1005	VOCs	3.0-3.5	11.0-11.5
S2316	MW-253	VOCs	3.5-4.0	5.5-6.0
S2317	MW-254	VOCs	11.5-12.0	15.5-16.0
S2318	MW-255	NA	NA	
S2321	S2321	VOCs	8.0-8.5	19.5-20.0
S2322	S2322	VOCs	9.0-9.5	11.5-12.0
S2323	S2323	TEL	18.0-18.5	
S2324	S2324	VOCs	8.0-8.5	19.5-20.0
S2325	S2325	VOCs	4.5-5.0	14.5-15.0
S2326	S2326	VOCs	8.5-9.0	12.0-12.5
S2327	S2327	VOCs	4.5-5.0	12.0-12.5
S2328	S2328	VOCs	4.0-4.5	7.5-8.0
S2329	S2329	VOCs	3.0-3.5	8.0-8.5
S2330	S2330	VOCs, As	1.5-2.0	2.5-3.0
			4.0-4.5	9.0-9.5
S2331	S2331	VOCs, As	1.5-2.0	4.0-4.5
			7.0-7.5	9.0-9.5
			11.01.5	

NA =Not Analyzed.

Two soil samples were typically collected at each boring location; however, the actual number of samples collected at each location was dependent upon the Sampling and Analysis Strategy detailed in the EY SRFI DWP. Soil boring S2323 was advanced to specifically address the potential for TEL impacts to soil, and no soil sample was collected at boring S2318 (converted to MW-255) since a shallow well with soil data already exists adjacent to this location. Three additional samples were collected from the 1.5 to 2.0 ft. bgs (A4), 4.0 to 4.5 ft. bgs (C1), and 9.0 to 9.5 ft. bgs (E3) intervals at the S2330 and S2331 boring locations to specifically address the potential for arsenic impacts to soil.

The first VOC soil sample at each boring location was taken from the core interval exhibiting the greatest potential for petroleum hydrocarbon impacted soil based upon visual, olfactory, and PID response. This typically occurred in the shallow fill material. A second sample was collected from the next deeper core interval exhibiting no potential for petroleum hydrocarbon impacted soil, based upon visual, olfactory, and PID response. Soil samples were then transferred into appropriate laboratory cleaned sample containers and placed in a cooler with ice for laboratory submittal.

Thirty-three soil samples were collected from 14 of the 15 soil borings advanced in the AOI 2 vicinity. Six samples were analyzed for arsenic via EPA Method SW-846 6010B, One sample was analyzed for TEL via EPA Method SW-846 8270C, and 26 samples were analyzed for TCL VOCs +10 via EPA Method SW-846 8260B.

AOI 2 Lithology and OVM Observations

The lithology within AOI 2 is variable, but may be generally characterized by the following stratigraphic progression from ground surface to boring termination; brown fine to coarse sand (0 to 3.0 ft. bgs), black fine to coarse sand, silt and clay (3.0 to 5.0 ft. bgs), red brown fine to coarse sand and clay (5.0 to 12.0 ft. bgs), and dark brown peat underlain by red brown silty clay (Clay Horizon A) (12.0 to 30.0 ft. bgs). The black sand was generally observed with petroleum odor and staining, occasionally with weathered petroleum product, and was discontinuous across AOI 2. Although discontinuous across the area, the peat is generally encountered at greater depth in an easterly direction. At S2321, peat was encountered between 9.5 to 10.0 ft. bgs. At S2327, located approximately 360 feet to the east of S2321, peat was encountered between 12.6 and 14.5 ft. bgs. At S2318, located approximately 160 feet eastward of S2327, peat was encountered between 22.0 and 24.0 ft. bgs. This west-east stratigraphic progression is depicted on AOI 2 Cross-Section A-A' (see Figure 24 and Figure 24A).

OVM readings across the AOI 2 Area were variable. The highest reading (1,703 ppm) was identified in S2321 at a depth of 8.0 to 8.5 ft. bgs on the eastern side of Tank 754 Basin (Figure 24). A petroleum odor was associated with this OVM reading, but no staining was evident. Only 0.5 feet below this interval, OVM readings dropped to 93.8 ppm at a depth of 9.0 to 9.5 ft. bgs. A second interval, between 12.0 to 12.5 ft. bgs, had an OVM reading of 1,526 ppm. Within 1.5 feet below this interval, the OVM readings dropped to 39.1 ppm, between 13.0 and 13.5 ft. bgs. The intermittent nature of the high

OVM readings, coupled with the lack of associated petroleum staining with those intervals, are indicative of fugitive vapors in the vicinity of S2321.

Soil boring S2326 was advanced approximately 110 feet east of Tank 760. An OVM reading of 738 ppm was observed at a depth of 8.5 to 9.0 ft. bgs and was associated with olive gray sand with slight petroleum staining and a petroleum odor. OVM readings in this boring dropped to 11.4 ppm at a depth of 12.0 to 12.5 ft. bgs. Historical borings located between S2321 and S2326 yielded OVM readings in excess of 300 ppm during previous site work. The additional soil borings S2321 and S2326 further constrain the OVM data model for this area when compared with Figure 24, compiled from the original RFI data (Figure 25). The OVM data model was also further constrained in the area surrounding new soil borings S2317 and S2318. OVM readings did not exceed 50 ppm in either S2317 or S2318.

The aerial extent of soil with organic vapors over 100 ppm was expanded to the north of Tank 760, through the addition of OVM data from S2305. The aerial extent of soil with organic vapors over 316 ppm was expanded in the areas surrounding new soil borings S2324 and S2325 as depicted in Figure 24. The highest OVM readings at each of these boring locations (460 ppm at S2305, 1,251 ppm at S2324, and 1,159 ppm at S2325) were associated with an interval of black fine to coarse sand with petroleum staining and odor. A weathered petroleum product associated with the black sand intervals was observed in the macro-cores at S2324 and S2325.

AOI 2 Soil Analytical Results

Of the 33 soil samples collected within AOI 2, only one sample (S2325C2) contained concentrations of VOCs in excess of the NJDEP NRDCSCC. Table 19 summarizes the soil analytical results at AOI 2.

Sample S2325C2 was collected between 4.5 and 5.0 ft. bgs, and contained benzene (17 mg/kg) in excess of the NJDEP NRDCSCC (13 mg/kg). This sampling location is approximately 240 feet southeast of Tank 760, outside of the tank basin, as depicted on Figure 26. The S2325C2 sample was collected from black sand with petroleum staining, petroleum odor, and weathered petroleum in the macro-core. This sand yielded an OVM reading of 1,159 ppm. The endpoint sample for this boring location (S2325H2) was collected between 14.5 to 15.0 ft. bgs, and contained no compounds in concentrations exceeding the NJDEP NRDCSCC, delineating the contamination vertically.

OVM readings at boring location S2321 were greater than 300 ppm as depicted on Figure 24; however sample S2321E1 contained benzene (1.2 mg/kg) and other VOCs in concentrations not exceeding the NJDEP NRDCSCC. OVM readings at boring location S2305 were greater than 300 ppm as depicted on Figure 24; however, sample S2305B3 contained no VOCs in concentrations exceeding the NJDEP NRDCSCC.

Sample S2323J1 was specifically collected and analyzed for TEL. No TEL above the method detection limit (MDL) was found in this sample. Samples collected from

Table 19. AOI 2 Soil Analytical Results

Sample ID	Sample Depth (ft. bgs.)	VOC Exceedances (mg/kg)	Total Arsenic Exceedances (mg/kg)	TEL Exceedances (mg/kg)
S2305B3	3.0-3.5	None	NA	NA
S2305F3	11.0-11.5	None	NA	NA
S2316B4	3.5-4.0	None	NA	NA
S2316C4	5.5-6.0	None	NA	NA
S2317F4	11.5-12.0	Benzene (3.3)*	NA	NA
S2317H4	15.5-16.0	None	NA	NA
S2321E1	8.0-8.5	Benzene (1.2)*	NA	NA
S2321J4	19.5-20.0	None	NA	NA
S2322E3	9.0-9.5	None	NA	NA
S2322F4	11.5-12.0	None	NA	NA
S2323J1	18.0-18.5	NA	NA	None
S2324E1	8.0-8.5	None	NA	NA
S2324J4	19.5-20.0	None	NA	NA
S2325C2	4.5-5.0	Benzene (17) Cyclohexane (170)*	NA	NA
S2325H2	14.5-15.0	None	NA	NA
S2326E2	8.5-9.0	Benzene (11)* Cyclohexane (160)* Xylene (91)*	NA	NA
S2326G1	12.0-12.5	None	NA	NA
S2327C2	4.5-5.0	None	NA	NA
S2327G1	12.0-12.5	None	NA	NA
S2328C1	4.0-4.5	None	NA	NA
S2328D4	7.5-8.0	None	NA	NA
S2329B3	3.0-3.5	None	NA	NA
S2329E1	8.0-8.5	None	NA	NA
S2330A4	1.5-2.0	NA	Arsenic (20.7)	NA
S2330B2	2.5-3.0	None	NA	NA
S2330C1	4.0-4.5	None	None	NA
S2330E3	9.0-9.5	NA	None	NA
S2331A4	1.5-2.0	NA	Arsenic (29.5)	NA
S2331C1	4.0-4.5	NA	Arsenic (25.4)	NA
S2331D3	7.0-7.5	None	NA	NA
S2331E3	9.0-9.5	NA	None	NA
S2331F3	11.0-11.5	None	NA	NA

*Exceeds RFI Evaluation Criteria only, does not exceed NJDEP NRDCSCC.

NA = Not Analyzed.

locations S2330 and S2331 at the 1.5 to 2.0 ft. bgs, 4.0 to 4.5 ft. bgs, and 9.0 to 9.5 ft. bgs intervals were analyzed for arsenic. Arsenic was detected in samples S2330A4 (20.7 mg/kg), S2331A4 (29.5 mg/kg), and S2331C1 (25.4 mg/kg) in concentrations exceeding the NJDEP NRDCSCC. A computer model of the aerial extent of arsenic exceeding the NJDEP NRDCSCC is depicted in Figure 21. Although arsenic exceeded the NJDEP NRDCSCC at shallow intervals at sample locations S2330 and S2331 (1.5 to 4.5 ft. bgs), endpoint samples for boring locations S2330 (S2330E3) and S2331 (S2331E3) contained arsenic at concentrations below the NJDEP NRDCSCC (1.93 mg/kg and 3.41 mg/kg, respectively).

Across the AOI 2 Area, no endpoint samples contained concentrations of any COCs in excess of the NJDEP NRDCSCC. Four cross sections of the EY AOI 2 Study area are depicted on Figure 24 and Figure 24A. Data collected during the SRFI has contributed significantly to vertical and horizontal delineation using three-dimensional modeling of the area, which is evident when comparing historical cross sections with cross sections generated after the SRFI. During Chevron's analysis of all AOI 2 historical soil data, it was evident that horizontal and vertical delineation of VOCs in soil had not been achieved as seen in the historical cross sections shown on Figure 24A. However, this analysis did indicate the location of data gaps to be studied during the SRFI soil investigation conducted in 2006. As such, soil samples collected during the SRFI enabled Chevron to complete the horizontal and vertical delineation of VOCs across AOI 2 as depicted on SRFI cross sections on Figure 24A, which included data from both the SRFI and historical soil data.

5.2.3 AOI 3

SRFI investigative work was conducted across AOI 3 and its vicinity (including AOCs 6B, 29, 45, and 46). During the SRFI, a total of 11 soil borings and two permanent groundwater monitoring wells were installed in the AOI 3 Area using the decision-based sampling and analysis strategy as detailed in the October 2006 SRFI DWP. This soil and groundwater investigation was conducted to further delineate COCs across AOI 3 and the vicinity. Table 20 summarizes the 11 soil borings advanced in AOI 3 during the SRFI.

Soil borings S2330 and S2331 were previously included in the discussion of AOI 2, but also will be included in the discussion of AOI 3, as the AOIs overlap at these locations.

Two soil samples were collected at VOC sampling locations, and four soil samples were collected at arsenic sampling locations. At some locations, VOC and arsenic samples were collected from the same borehole. Soil samples collected from boring locations S2336, S2337, and S2434 were analyzed for SVOCs. For standard VOC soil sampling in AOI 3, the first soil sample at each boring location was taken from the core interval exhibiting the greatest potential for petroleum hydrocarbon impacted soil based upon visual, olfactory, and PID response. This typically occurred in the shallow fill material. A second sample was collected from the next deeper core interval exhibiting no potential for petroleum hydrocarbon impacted soil, based upon visual, olfactory, and PID response. Arsenic and SVOC samples were collected from specific intervals based upon the

Table 20. AOI 3 SRFI Soil Borings

Boring ID	Work Plan ID	Parameter(s)	Sample Depths (ft. bgs)	
S2319	MW-256	VOCs, As	1.5-2.0	4.0-4.5
			5.5-6.0	9.0-9.5
			15.0-15.5	
S2320	MW-257	As	1.5-2.0	4.0-4.5
			9.0-9.5	
S2330	S2330	VOCs, As	1.5-2.0	2.5-3.0
			4.0-4.5	9.0-9.5
S2331	S2331	VOCs, As	1.5-2.0	4.0-4.5
			7.0-7.5	9.0-9.5
			11.0-11.5	
S2332	S2332	VOCs	8.0-8.5	13.0-13.5
S2333	S2333	As	1.5-2.0	4.0-4.5
			9.0-9.5	
S2334	S2334	As	1.5-2.0	4.0-4.5
			9.0-9.5	
S2335	S2335	As	1.5-2.0	4.0-4.5
			9.0-9.5	
S2336	S2336	SVOCs	14.5-15.0	
S2337	S2337	SVOCs	14.5-15.0	
S2434	S2434	SVOCs	24.5-25.0	

Sampling and Analysis Strategy detailed in the EY SRFI DWP. Soil samples were then transferred into appropriate laboratory cleaned sample containers and placed in a cooler with ice for laboratory submittal.

A total of 32 soil samples were collected from the 11 soil borings advanced in the AOI 3 vicinity. Twenty-one samples were analyzed for arsenic via EPA Method SW-846 6010B, three samples were analyzed for SVOCs via EPA Method SW-846 8270C, and eight samples were analyzed for TCL VOCs +10 via EPA Method SW-846 8260B.

AOI 3 Lithology and OVM Observations

The lithology within AOI 3 is variable, but may be generally characterized by the following stratigraphic progression from ground surface to boring termination; brown to red brown fine to coarse sand (0 to 4.0 ft. bgs), black fine to coarse sand, clay and gravel (3.0 to 10.0 ft. bgs), and dark brown peat, underlain by dark gray clayey silt with root fragments (Clay Horizon A) (9.0 to 15.0 ft. bgs). The black sand was generally observed with petroleum odor and staining, occasionally with weathered petroleum product, and was discontinuous across AOI 3. The fill/native interface in AOI 3 is defined by Clay Horizon A, which consists of dark gray clayey silt with root fragments, and is generally encountered at greater depth in an easterly direction. At S2333, clayey silt with root fragments was encountered between 9.0 and 10.0 ft. bgs on the western side of AOI 3. At S2332, clayey silt with root fragments was encountered between 12.4 and 15.0 ft. bgs,

150 feet eastward of S2333. Approximately 200 feet east of S2332, clayey silt with root fragments was encountered at 15.0 ft. bgs at S2319.

OVM readings across the AOI 3 Area were variable. The highest reading (1,054 ppm) was identified in S2332 at a depth of 11.5 to 12.0 ft. bgs on the northeastern side of Tank 749 (Figure 27). A strong petroleum odor and petroleum staining were associated with this OVM reading. Only 0.5 feet below this interval, OVM readings dropped to 10.7 ppm at a depth of 12.0 to 12.5 ft. bgs, in the native clayey silt with root fragments.

Of the SRFI borings conducted in AOI 3, only soil borings S2319, S2332, and S2336 yielded OVM readings in excess of 100 ppm. Historical borings within AOI 3 yielded OVM readings in excess of 300 ppm during previous site work. However, during the SRFI, only soil boring S2332 yielded OVM readings in excess of 300 ppm. The SRFI soil borings did not significantly alter the OVM model for AOI 3 (Figure 27) when compared to the original RFI OVM model (Figure 25).

AOI 3 Soil Analytical Results

None of the eight soil samples collected and analyzed for VOCs within AOI 3 contained VOC concentrations in excess of the NJDEP NRDCSCC. However, soil sampling locations with benzene in excess of 1 mg/kg are depicted on Figure 28. Table 21 summarizes the analytical results from AOI 3.

Four cross sections of the EY AOI 3 Study area are depicted on Figure 27 and Figure 27A. Data collected during the SRFI has contributed significantly to vertical and horizontal delineation using three-dimensional modeling of the area, which is evident when comparing historical cross sections with cross sections generated after the SRFI (see Figure 27 and Figure 27A). During Chevron's analysis of all AOI 3 historical soil data, it was evident that horizontal and vertical delineation of VOCs in soil had not been achieved as seen in the historical cross sections shown on Figure 27A. However, this analysis did indicate the location of data gaps to be studied during the SRFI soil investigation conducted in 2006. As such, soil samples collected during the SRFI enabled Chevron to complete the horizontal and vertical delineation of VOCs across AOI 3 as depicted on SRFI cross sections on Figure 27A, which included data from both the SRFI and historical soil data.

Two samples (S2336H2 and S2337H2) were analyzed for SVOCs and contained concentrations of target analytes above the NJDEP NRDCSCC. Sample S2336H2 was collected between 14.5 and 15.0 ft. bgs, and contained a concentration of benzo(a)pyrene (1.70 mg/kg) in excess of the NJDEP NRDCSCC (0.66 mg/kg). This sampling location is in the central portion of the #5 Berth Area, as depicted on Figure 27. Sample S2336H2 was collected from dark gray silt, immediately above the clayey silt with root fragments. Sample S2337H2 was collected between 14.5 and 15.0 ft. bgs, and contained concentrations of benzo(a)anthracene (18 mg/kg), benzo(a)pyrene (7.6 mg/kg), benzo(b)fluoranthene (6.2 mg/kg), and dibenzo(a,h)anthracene (0.86 mg/kg) in concentrations exceeding the NJDEP NRDCSCC (4.0 mg/kg, 0.66 mg/kg, 4.0 mg/kg, and

Table 21. AOI 3 Soil Analytical Results

Sample ID	Sample Depth (ft. bgs.)	VOC Exceedances (mg/kg)	SVOC Exceedances (mg/kg)	Metals Exceedances (mg/kg)
S2319A4	1.5-2.0	NA	NA	As (94.5)
S2319C1	4.0-4.5	NA	NA	As (48.5)
S2319C4	5.5-6.0	Benzene (1.2)*	NA	NA
S2319E3	9.0-9.5	NA	NA	As (144)
S2319H3	15.0-15.5	None	NA	NA
S2320A4	1.5-2.0	NA	NA	As (31.6)
S2320C1	4.0-4.5	NA	NA	As (55.1)
S2320E3	9.0-9.5	NA	NA	As (50.5)
S2330A4	1.5-2.0	NA	NA	As (20.7)
S2330B2	2.5-3.0	None	NA	NA
S2330C1	4.0-4.5	None	NA	None
S2330E3	9.0-9.5	NA	NA	None
S2331A4	1.5-2.0	NA	NA	As (29.5)
S2331C1	4.0-4.5	NA	NA	As (25.4)
S2331D3	7.0-7.5	None	NA	NA
S2331E3	9.0-9.5	NA	NA	None
S2331F3	11.0-11.5	None	NA	NA
S2332E1	8.0-8.5	Benzene (4.1J)*	NA	NA
S2332G3	13.0-13.5	None	NA	NA
S2333A4	1.5-2.0	NA	NA	As (74.9)
S2333C1	4.0-4.5	NA	NA	None
S2333E3	9.0-9.5	NA	NA	As (309)
S2334A4	1.5-2.0	NA	NA	As (58.2)
S2334C1	4.0-4.5	NA	NA	None
S2334E3	9.0-9.5	NA	NA	None
S2335A4	1.5-2.0	NA	NA	As (62.5)

Table 21. AOI 3 Soil Analytical Results

Sample ID	Sample Depth (ft. bgs.)	VOC Exceedances (mg/kg)	SVOC Exceedances (mg/kg)	Metals Exceedances (mg/kg)
S2335C1	4.0-4.5	NA	NA	As (431)
S2335E3	9.0-9.5	NA	NA	As (74.5)
S2336H2	14.5-15.0	NA	Benzo(a)anthracene (3)* Benzo(a)pyrene (1.7) Benzo(b)fluoranthene (1.7)* Carbazole (1.8)*	NA
S2337H2	14.5-15.0	NA	Acenaphthene (110)* Benzo(a)anthracene (18) Benzo(a)pyrene (7.6) Benzo(b)fluoranthene (6.2) Benzo(k)fluoranthene (3.1)* Carbazole (9.4)* Dibenz(a,h)anthracene (0.86J) Indeno(1,2,3-cd)pyrene (2.8)* Naphthalene (330)*	NA
S2434M2	24.5-25.0	NA	None	NA

*Exceeds RFI Evaluation Criteria only, does not exceed NJDEP NRDCSCC.

NA = Not Analyzed.

0.66 mg/kg, respectively). Sample S2337H2 was collected approximately 100 feet south of S2336 in the #5 Berth Area from a dark gray clayey silt with root fragments.

The contaminant concentrations observed in the sample intervals suggested that contaminants were sticking to the sides of the macro-core sampler during advancement through heavy contamination zones at shallower depth, thus yielding inaccurate soil chemistry at greater depth. To address this concern, an additional soil boring (S2434) was advanced immediately adjacent to the S2336 location. In this soil boring, steel casing was installed to a depth of 20.0 ft. bgs, and was grouted in place on March 6, 2007. After allowing the grout to set, two macro-cores were advanced through the bottom of the casing on March 12, 2007. One soil sample (S2434M2) was collected from the 24.5 to 25.0 ft. bgs interval and analyzed for SVOCs via EPA Method SW-846 8270C. No SVOCs were detected at concentrations exceeding the NJDEP NRDCSCC.

Previous site work within AOI 3 identified four locations (S0499, S0500, S0892, and S0938) with concentrations of total lead exceeding the NJDEP NRDCSCC. These locations are likely associated with TEL burial locations, as depicted in Figure 20.

Twenty-one samples from seven boring locations were collected and analyzed via EPA Method SW-846 6010B for arsenic. At sample locations S2319, S2320, S2333, and S2335, endpoint samples exceeded the NJDEP NRDCSCC for arsenic (20 mg/kg). A computer model of the aerial extent of arsenic exceeding the NJDEP NRDCSCC is depicted in Figure 21. Samples at these locations were collected between 1.5 to 9.5 ft. bgs, from fill material consisting of red brown sand and clay, grading to black sand and gravel, occasionally with petroleum staining and odor. Although arsenic exceeded the NJDEP NRDCSCC at shallow intervals at sample locations S2330, S2331, and S2334 (1.5 to 4.5 ft. bgs), endpoint samples from the E3 interval (9.0 to 9.5 ft. bgs) at these locations contained concentrations of arsenic below the NJDEP NRDCSCC.

5.2.4 AOCs 38 & 39

SRFI investigative work conducted across AOCs 38 and 39 and the vicinity included seven soil borings installed using the decision-based sampling and analysis strategy as detailed in the December 2006 SRFI DWP. This soil and groundwater investigation was conducted to further delineate COCs across AOCs 38 and 39. Table 22 summarizes the seven soil borings advanced in AOCs 38 and 39 during the SRFI.

In the AOC 38 and AOC 39 vicinity, two soil samples were typically collected at each boring location; however, the actual number of samples collected at each location was dependant upon the Sampling and Analysis Strategy detailed in the EY SRFI DWP. The first soil sample at each boring location was taken from the core interval exhibiting the greatest potential for petroleum hydrocarbon impacted soil based upon visual, olfactory, and PID response. This typically occurred in the shallow fill material. A second sample was collected from the next deeper core interval exhibiting no potential for petroleum hydrocarbon impacted soil, based upon visual, olfactory, and PID response. Soil samples

Table 22. AOCs 38 & 39 SRFI Soil Borings

Boring ID	Work Plan ID	Parameter(s)	Sample Depths (ft. bgs)	
S2429	S2429	VOCs	3.0-3.5	
S2430	S2430	VOCs	0.5-1.0	5.5-6.0
S2431	S2431	VOCs	1.5-2.0	4.5-5.0
S2432	S2432	VOCs	2.0-2.5	7.5-8.0
S2433	S2433	VOCs	3.0-3.5	7.5-8.0
S2435	S2435	VOCs	4.0-4.5	5.5-6.0
S2451	S2451	VOCs	1.5-2.0	5.0-5.5

were then transferred into appropriate laboratory cleaned sample containers and placed in a cooler with ice for laboratory submittal.

Thirteen soil samples were collected from the seven soil borings advanced in the AOC 38 and AOC 39 vicinity. Each sample was analyzed for TCL VOCs +10 via EPA Method SW-846 8260B.

AOCs 38 and 39 Lithology and OVM Observations

The lithology within AOCs 38 and 39 is variable, but may be generally characterized by the following stratigraphic progression from ground surface to boring termination; brown sand and clay (0 to 3.0 ft. bgs), gray silty sand and clay (3.0 to 7.0 ft. bgs), dark gray silty clay (7.0 to 9.0 ft. bgs), and red brown silty clay and sand (9.0 to 20.0 ft. bgs). In general, the fill/native interface across the area was between 2.5 to 3.0 ft. bgs.

OVM readings across the AOC 38 and 39 Area were variable. The highest reading (1,730 ppm) was identified in S2433 at a depth of 2.5 to 3.0 ft. bgs on the southeastern side of Tank 753 (Figure 29). A petroleum odor was associated with this OVM reading, but no staining was evident. Only 0.5 feet below this interval, OVM readings dropped to 75.7 ppm at a depth of 3.5 to 4.0 ft. bgs. A second interval, between 4.0 to 4.5 ft. bgs, had an OVM reading of 1,723 ppm. Within 0.5 feet below this interval, the OVM readings dropped to 52.0 ppm, between 4.5 to 5.0 ft. bgs. The intermittent nature of the high OVM readings, coupled with the lack of associated petroleum staining with those intervals, are indicative of fugitive vapors in the vicinity of S2433.

Soil borings S2431 and S2451 also yielded OVM readings above 300 ppm. Soil boring S2451 was advanced directly between Tanks 753 and 754, but did not have any petroleum staining or odor associated with the OVM readings of 400 ppm and 211 ppm at depths of 1.5 to 2.0 ft. bgs and 3.5 to 4.0 ft. bgs, respectively. Both OVM readings were collected from a red brown fine to coarse sand. The intermittent nature of the high OVM readings, coupled with the lack of associated petroleum staining with those intervals, are indicative of fugitive vapors in the S2451 location. Soil boring S2431 yielded OVM readings above 300 ppm in a shallow (1.0 to 2.0 ft. bgs), petroleum stained, brown gravel with a petroleum odor. Soil boring S2431 was located approximately 130 feet south of Tank 753. Historical borings S0886, S0965, and S1791 yielded OVM

readings in excess of 300 ppm during previous site work. The addition of soil borings S2429, S2431, S2432, and S2435 further constrain the OVM data model for this area when compared with Figure 29, compiled from the original RFI data (Figure 25). OVM data did not exceed 1 ppm in soil borings S2429, S2432, and S2435.

The aerial extent of soil with organic vapors over 100 ppm was expanded to the southeast of Tank 753 and between Tanks 753 and 754, through the addition of OVM data from S2433 and S2451. As previously discussed, the high OVM readings at these locations were indicative of fugitive vapors. In addition, an OVM reading above 100 ppm was recorded at S2430, immediately adjacent and to the south of Tank 754. The intermittent nature of the high OVM readings, coupled with the lack of associated petroleum staining with those intervals, are indicative of fugitive vapors in the S2430 location.

AOCs 38 and 39 Soil Analytical Results

None of the 13 soil samples collected within AOCs 38 and 39, contained concentrations of VOCs in excess of the NJDEP NRDCSCC. Two cross-sections of the AOC 38 and 39 Study Area are depicted on Figure 29 and Figure 29A. Horizontal and vertical delineation of VOCs across AOCs 38 and 39 is depicted on the two cross sections based on SRFI and historical soil data. Table 23 summarizes the soil analytical results from AOCs 38 and 39.

Table 23. AOCs 38 and 39 Soil Analytical Results

Sample ID	Sample Depth (ft. bgs)	VOC Exceedances (mg/kg)
S2429B3	3.0-3.5	None
S2430A2	0.5-1.0	None
S2430C4	5.5-6.0	None
S2431A4	1.5-2.0	Benzene (10)* Cyclohexane (180)*
S2431C2	4.5-5.0	None
S2432B1	2-2.5.0	None
S2432D4	7.5-8.0	None
S2433B3	3.0-3.5	Benzene (9.6)* Xylene (180)*
S2433D4	7.5-8.0	None
S2435C1	4.0-4.5	None
S2435C4	5.5-6.0	None
S2451A4	1.5-2.0	None
S2451C3	5.0-5.5	None

*Exceeds RFI Evaluation Criteria only, does not exceed NJDEP NRDCSCC

Although OVM readings at boring locations S2433 and S2451 were greater than 300 ppm as depicted on Figure 29, samples collected from these locations did not contain VOCs in concentrations exceeding the NJDEP NRDCSCC (see Figure 30). No endpoint samples

contained concentrations of any target analytes in excess of the NJDEP NRDCSCC (see Figure 29A).

5.2.5 AOC 31

Two monitoring wells (MW-250 and MW-251) were installed in the Tank 772 vicinity to vertically and horizontally delineate the dissolved phase contaminant plume in this area. Prior to well installation, soil samples were collected from the MW-250 boring (S2313) to vertically delineate VOC and SVOC impacts to soil. Figure 31 depicts the location of SRFI soil samples collected at AOC 31. Table 24 summarizes the two soil borings advanced in AOC 31 during the SRFI.

Table 24. AOC 31 SRFI Soil Borings

Boring ID	Work Plan ID	Parameter(s)	Sample Depths (ft. bgs)	
S2313	MW-250	VOCs	4.5-5.0	9.5-10.0
S2314	MW-251	NS	NA	

NA = Not Analyzed.

AOC 31 Soil Analytical Results

Two soil samples (S2313C2 and S2313E4) were collected from the 4.5 to 5.0 ft. bgs and 9.5 to 10.0 ft. bgs intervals. The shallow sample S2313C2 was collected from a sandy clay with petroleum odor and petroleum staining. This sample contained benzene (74 mg/kg) and total xylenes (1,400 mg/kg) in concentrations exceeding the NJDEP NRDCSCC (13 mg/kg and 1,000 mg/kg, respectively). The deeper sample, S2313E4, contained no analytes in concentrations exceeding the NJDEP NRDCSCC. Table 25 summarizes the soil analytical results from AOC 31.

Table 25. AOC 31 Soil Analytical Results

Sample No.	Sample Depth (ft. bgs)	VOC Exceedances (mg/kg)
S2313C2	4.5-5.0	Benzene (74) Cyclohexane (380)* Ethylbenzene (320)* Xylene (1,400)
S2313E4	9.5-10.0	None

*Exceeds RFI Evaluation Criteria only; does not exceed NJDEP NRDCSCC.

5.3 SRFI Groundwater Findings – North Field/Main Yard

In addition to the 27 monitoring wells installed during the SRFI, Chevron currently monitors a network of 169 monitoring wells at the Perth Amboy, NJ facility, (for a total of 196 monitoring wells). The wells are sampled to satisfy the requirements of various projects on-site including the RFI, SRFI, CMS, LNAPL, Closure, and AOC 36 investigations. In addition, Chevron monitors a network of 22 Sentinel wells at the boundaries between the facility property and surface water bodies. These wells are

sampled for various parameters depending on their project requirements, including VOCs, SVOCs, metals, ammonia, and natural attenuation parameters. Closure wells are sampled quarterly, Sentinel wells are sampled semi-annually, and most other wells are sampled on an annual basis. 75 of the 196 wells have been installed since the Full RFI Report was submitted in 2003. Chevron maintains an additional 57 monitoring wells and piezometers which, with to the 196 monitoring wells currently being sampled, are gauged quarterly to provide groundwater elevation data for creating contour maps. The Groundwater Monitoring Program is periodically evaluated to optimize sample frequency and parameters, and efficiently provide data for the various programs on-site.

The SRFI groundwater findings are presented in this section on a site-wide scale. They include shallow groundwater contour maps for 2003 and 2007 (see Figure 32 and Figure 33, respectively), as well as a new deep groundwater contour map for 2007 (see Figure 34). These contour maps were generated using the latest shallow wells and deep wells, as well as existing wells as appropriate. Based on these latest contour maps, groundwater flow directions and gradients were recalculated and are presented in this section. Furthermore, with the addition of the ten new deep wells, Chevron was able to calculate the vertical hydraulic gradient in several areas of concern. These calculations were developed using the USEPA Site Assessment Calculations web-site (see Appendix F).

SRFI COC site-wide distribution maps are included for ammonia, arsenic, benzene, cyclohexane, total lead, and methylcyclohexane (see Figure 35 through Figure 40, respectively). These COCs were chosen for illustration based on their occurrence across the site and their risk to human health. Appendix G presents all laboratory analytical data from 2003 to 2007 for all groundwater monitoring wells, and their respective SRFI Evaluation Criteria. Appendix E contains a Data Validation Report with the results of the QA/QC analysis for the analytical data.

5.3.1 AOI NF2

NF2 Permanent Monitoring Well Installations

Three permanent groundwater monitoring wells (MW-192, MW-240, and MW-242) were installed in the NF2 Area during the SRFI. A soil boring was advanced at monitoring well locations MW-240 and MW-242 prior to well installation to obtain lithologic and OVM screening data (S2118 at MW-240 and S2103 at MW-242).

Two shallow permanent wells (MW-192 and MW-242) were screened in the upper water-bearing zone in the fill material. The maximum depth of each borehole ranged from 9.0 ft. bgs (MW-192) to 15.0 ft. bgs (S2103/MW-242), and five foot screens were set across the water table at bottom depths ranging from 8.0 ft. bgs (MW-242) to 9.0 ft. bgs (MW-192) (see Table 26).

One deep permanent well (MW-240) was screened in the lower water-bearing zone beneath the fill and Clay Horizon A (see Table 26).

Table 26. AOI NF2 SRFI Monitoring Well Construction Details

Well ID	NJDEP Permit No.	Install Date	TOS (ft. bgs)	BOS (ft. bgs)	Steel Casing (ft. bgs)	Elev. TOS (ft)	Elev. BOS (ft)	Grnd. Elev. (ft)	MPE (ft)
MW-192	2600081231	3/6/07	4.00	9.00	N/A	9.80	4.80	13.80	16.33
MW-240	2600080795	10/31/06	22.00	27.00	20.5	-8.22	-13.22	13.78	13.46
MW-242	2600080797	10/25/06	3.00	8.00	N/A	6.50	1.50	9.50	11.14

TOS = Top of Screen

BOS = Bottom of Screen

Elev. = Elevation

Grnd. = Ground

MPE = Measuring Point Elevation

N/A = Not Applicable

NF2 Shallow Permanent Monitoring Well Gauging Results

Site-wide groundwater contour maps from 2003 (see Figure 32) indicate average groundwater flow direction across the entire NF2 Area is generally east-northeast, towards Woodbridge Creek. The February 2007 shallow groundwater contour map (see Figure 33) confirms groundwater flow direction is generally east-northeast in this area. The average gradient across the area was calculated to be 0.002167, and average flow direction was to the east, based upon data collected during the February 2007 site-wide gauging event.

NF2 Shallow Monitoring Well Analytical Results

Two new shallow, permanent, monitoring wells (MW-192 and MW-242) were installed in the NF2 Area during the SRFI. Following groundwater gauging, a sample was collected from each of these monitoring wells and analyzed for VOCs, SVOCs, and metals. Neither groundwater sample contained VOCs or SVOCs in concentrations exceeding the SRFI Evaluation Criteria. There were several dissolved metals in concentrations exceeding the SRFI Evaluation Criteria for samples collected from MW-192 and MW-242. Samples from both wells contained concentrations of aluminum, total and dissolved iron, and manganese exceeding the SRFI Evaluation Criteria. In addition, MW-242 contained dissolved concentrations of sodium exceeding the SRFI Evaluation Criteria. Appendix G presents all laboratory analytical data for the shallow monitoring wells, including dissolved metals concentrations, and the respective SRFI Evaluation Criteria.

NF2 Deep Monitoring Well Gauging Results

The deep groundwater contour map generated from the February 2007 site-wide gauging data (see Figure 34), indicates that groundwater flow across the NF2 area is generally northeast, towards Woodbridge Creek. Deep groundwater flow across the area occurs within the first water-bearing zone of the native material, and flows under an average gradient of 0.00817.

One deep monitoring well (MW-240) was installed within NF2 during the SRFI. This well was paired with a previously installed shallow well to investigate the hydrogeologic relationship between the first shallow and first native water-bearing zones across the NF2 Area. A vertical hydraulic gradient was calculated from the February 2007 gauging data using the USEPA Site Assessment Calculations web-site (2007b), and is included in Appendix F.

For the well pair RW-02 and MW-240, an upward vertical gradient of 0.1409 was calculated from deep well MW-240 to shallow well RW-02. Based upon the boring logs from the RW-02 and MW-240 installations, both wells intersect an organic clay/peat horizon at approximately 12.0 ft. bgs. Based upon the evidence of an upward vertical gradient between these wells, and the slightly artesian condition found within deep well

MW-240, the organic clay/peat horizon appears to be hydraulically isolating the first shallow water-bearing zone from the first native water-bearing zone in this location.

NF2 Deep Monitoring Well Analytical Results

Following groundwater gauging of MW-240 and RW-02, groundwater samples were collected and analyzed for VOCs, SVOCs, and metals. Dissolved concentrations of benzene (190 µg/L), cyclohexane (120 µg/L), and methylcyclohexane (150 µg/L) were detected in groundwater from RW-02 in concentrations exceeding the SRFI Evaluation Criteria (1 µg/L, 100 µg/L, and 100 µg/L respectively). However, no VOCs were detected in MW-240, which provides further evidence of hydraulic isolation between the first shallow water-bearing zone and first native water-bearing zone in this location. No SVOCs were detected in concentrations exceeding the SRFI Evaluation Criteria in groundwater samples from MW-240 and RW-02.

Samples from RW-02 and MW-240 contained concentrations of total iron exceeding the SRFI Evaluation Criteria. Additionally, RW-02 contained dissolved concentrations of iron, arsenic, manganese, and sodium above the SRFI Evaluation Criteria. Appendix G presents all laboratory analytical data for the deep monitoring wells, including dissolved metals concentrations, and their respective SRFI Evaluation Criteria.

5.3.2 AOI NF5

NF5 Permanent Monitoring Well Installations

Three permanent groundwater monitoring wells (MW-237, MW-238, and MW-241) were installed in NF5 during the SRFI. A soil boring was advanced at each monitoring well location prior to well installation to obtain lithologic and OVM screening data (S2090 at MW-237, S2129 at MW-238 and S2123 at MW-241).

One shallow permanent monitoring well (MW-241) was screened in the upper water-bearing zone in the fill. The maximum depth of the borehole was 15.0 ft. bgs, and a five foot screen was set across the water table with a bottom depth of 12.0 ft. bgs (see Table 27).

Two deep permanent monitoring wells (MW-237 and MW-238) was screened in the lower water-bearing zone beneath the fill and Clay Horizon A (see Table 27).

NF5 - Shallow Permanent Monitoring Well Gauging Results

Site-wide groundwater contour maps from 2003 (see Figure 32) indicate average groundwater flow direction across the entire NF5 Area is variable, due to a relative hydrologic plateau across the area. Flow is generally split between the northeast and southwest directions. The February 2007 shallow groundwater contour map (see Figure 33) confirms groundwater flow direction is variable across this area. The average

Table 27. AOI NF5 – SRFI Monitoring Well Construction Details

Well ID	NJDEP Permit No.	Install Date	TOS (ft. bgs)	BOS (ft. bgs)	Steel Casing (ft. bgs)	Initial Elev. TOS (ft)	Initial Elev. BOS (ft)	Initial Grnd. Elev. (ft)	Initial MPE (ft)
MW-237	2600080792	10/30/06	22.00	27.00	21	-16.00	-21.00	6.00	8.65
MW-238	2600080793	11/7/06	20.00	25.00	19.00	-15.30	-20.30	4.70	6.78
MW-241	2600080796	10/25/06	7.00	12.00	N/A	4.85	-0.15	11.85	11.59

TOS = Top of Screen

BOS = Bottom of Screen

Elev. = Elevation

Grnd. = Ground Surface

MPE = Measuring Point Elevation

N/A = Not Applicable

gradient across the area was calculated to be 0.003849, and average flow direction was southwest, based upon data collected during the February 2007 site-wide gauging event.

NF5 Shallow Monitoring Well Analytical Results

One new shallow, permanent, monitoring well (MW-241) was installed in the NF5 Area during the SRFI. Following groundwater gauging, groundwater samples were collected from this monitoring well on December 6, 2006 (M241A1) and May 15, 2007 (M241A2) and analyzed for VOCs, SVOCs, and metals. These groundwater samples contained no VOCs or SVOCs in concentrations exceeding the SRFI Evaluation Criteria. There were several dissolved metals at concentrations exceeding the SRFI Evaluation Criteria in the groundwater samples collected from MW-241, including aluminum, total and dissolved iron, manganese, and sodium. Appendix G presents all laboratory analytical data for the shallow monitoring wells, including dissolved metals concentrations, and their respective SRFI Evaluation Criteria.

NF5 Deep Monitoring Well Gauging Results

The deep groundwater contour map generated from the February 2007 site-wide gauging data (see Figure 34), indicates that groundwater flow across the NF5 Area is generally north-northeast, towards Woodbridge Creek. Deep groundwater flow across the area occurs within the first water-bearing zone of the native material, and flows under an average gradient of 0.00321.

Two deep monitoring wells (MW-237 and MW-238) were installed within NF5 during the SRFI. These wells were paired with previously installed shallow wells (MW-136 and MW-117, respectively) to investigate the hydrogeologic relationship between the first shallow and first native water-bearing zones across the NF5 Area. A vertical hydraulic gradient was calculated from the February 2007 gauging data using the USEPA Site Assessment Calculations web-site (2007b), and is included in Appendix F.

For the well pair MW-136 and MW-237, a downward vertical gradient of 0.07548 was calculated, from shallow well MW-136 to deep well MW-237. Based upon the boring logs from the MW-136 and MW-237 installations, both MW-136 and MW-237 intersect Clay Horizon A between 4.0 and 6.0 ft. bgs. In addition, the descriptions of the sediments above and below Clay Horizon A are similar between these two wells. Despite the continuity in Clay Horizon A between these wells, the evidence of a downward vertical gradient between the wells suggests a degree of hydraulic interconnectivity between the first shallow water-bearing zone and first native water-bearing zone in this location.

For the well pair MW-117 and MW-238, an upward vertical gradient of 0.1112 was calculated from deep well MW-238 to shallow well MW-117. Based upon the boring logs from the MW-117 and MW-238 installations, both wells intersect Clay Horizon A at approximately 6.0 ft. bgs. Based upon the evidence of an upward vertical gradient between these wells and the artesian condition found within deep well MW-238, Clay

Horizon A appears to be hydraulically isolating the first shallow water-bearing zone from the first native water-bearing zone in this location.

NF5 Deep Monitoring Well Analytical Results

Following groundwater gauging of MW-136 and MW-237, groundwater samples were collected and analyzed for VOCs, SVOCs, and metals on May 24 and May 10, 2007, respectively. Although there is evidence of hydraulic interconnectivity between water-bearing zones from MW-136 and MW-237, no dissolved VOCs or SVOCs were detected in groundwater samples from either well in concentrations exceeding the SRFI Evaluation Criteria.

Groundwater samples collected from MW-136 and MW-237 contained dissolved concentrations of total iron, manganese, and sodium in concentrations exceeding the SRFI Evaluation Criteria for these metals. In addition, the most recent sample collected from MW-136 on May 24, 2007 contained dissolved iron at a concentration exceeding the SRFI Evaluation Criteria. Appendix G presents all laboratory analytical data for monitoring wells MW-136 and MW-237, including dissolved metals concentrations and their respective SRFI Evaluation Criteria.

Following groundwater gauging of MW-117 and MW-238, groundwater samples were most recently collected and analyzed for VOCs, SVOCs, and metals on May 11, 2007 (MW-238) and June 6, 2007 (MW-117). During the June 6, 2007 sampling of MW-117, sample M117B1 was analyzed for BTEX, and benzene (840 µg/L) was detected above the SRFI Evaluation Criteria (1 µg/L). In addition, SVOCs including p-cresol (640 µg/L), o-cresol (550 µg/L), and 2,4-dimethylphenol (2,700 µg/L), were detected above the SRFI Evaluation Criteria (100 µg/L, 100 µg/L, and 100 µg/L, respectively). In contrast, no VOCs were detected in MW-238 in either of the most recent sampling events for this well (December 15 and May 11, 2007). Only one SVOC, bis(2-ethylhexyl)phthalate (8 µg/L), was detected above the SRFI Evaluation Criteria (3 µg/L), and has never been detected in MW-117. This analytical data provides further evidence of hydraulic isolation between the first shallow water-bearing zone and first native water-bearing zone in this location.

Historical groundwater data from MW-117 indicate dissolved metals exceeding the SRFI Evaluation Criteria, including arsenic, total iron, lead, manganese, and sodium. The two most recent samples from MW-238 also had concentrations of arsenic, total iron, manganese, and sodium exceeding the SRFI Evaluation Criteria. In addition, MW-238 also contained aluminum in excess of the SRFI Evaluation Criteria. Appendix G presents all laboratory analytical data for the groundwater monitoring wells, including metals concentrations, and their respective SRFI Evaluation Criteria.

5.3.3 AOI NF6

NF6 Permanent Monitoring Well Installations

Three permanent groundwater monitoring wells (MW-239, MW-243, and MW-244) were installed in NF6 during the SRFI. A soil boring was advanced at each monitoring well location prior to well installation to obtain lithologic and OVM screening data (S2116 at MW-239 and S2108 at MW-243 and MW-244).

One shallow permanent monitoring well (MW-243) was screened in the upper water-bearing zone in the fill. The maximum depth of the borehole was 8.5 ft. bgs, and a five foot screen was set across the water table with a bottom depth of 8.5 ft. bgs (see Table 28).

Two deep permanent monitoring wells (MW-239 and MW-244) were screened in the lower water-bearing zone beneath the fill and Clay Horizon A (see Table 28).

NF6 Shallow Permanent Monitoring Well Gauging Results

Site-wide groundwater contour maps from 2003 (see Figure 32) indicate that the average groundwater flow direction across the entire NF6 Area is north-northeast towards Woodbridge Creek. The February 2007 shallow groundwater contour map (see Figure 33) confirms groundwater flow direction is north-northeast across this area. The average gradient across the area was calculated to be 0.006481, and average flow direction was north-northeast, based upon data collected during the February 2007 site-wide gauging event.

NF6 Shallow Monitoring Well Analytical Results

One new shallow, permanent, monitoring well (MW-243) was installed in the NF6 Area during the SRFI. Following groundwater gauging, groundwater samples were collected from this monitoring well on December 4, 2006 (M243A1) and May 10, 2007 (M243A2) and analyzed for VOCs, SVOCs, and metals. Benzene was the only VOC compound detected in M243A1 (4,000 µg/L) and M243A2 (2,300 µg/L), in concentrations exceeding the SRFI Evaluation Criteria (1 µg/L). Concentrations of SVOCs 2,4-dimethylphenol and 2-methylnaphthalene in M243A1 (220 µg/L and 260 µg/L, respectively) and in M243A2 (170 µg/L and 110 µg/L, respectively) exceeded the SRFI Evaluation Criteria (100 µg/L and 100 µg/L, respectively). Only the first sample collected, M243A1, contained the SVOCs benzo(a)anthracene (2J µg/L) and o-cresol (110 µg/L) in concentrations exceeding the SRFI Evaluation Criteria (0.1 µg/L and 100 µg/L, respectively). There were several dissolved metals in concentrations exceeding the SRFI Evaluation Criteria in the groundwater samples collected from MW-243, including arsenic, lead, sodium, total iron, manganese, and cobalt. Appendix G presents all laboratory analytical data for the shallow monitoring wells, including dissolved metals concentrations, and their respective SRFI Evaluation Criteria.

Table 28. AOI NF6 – SRFI Monitoring Well Construction Details

Well ID	NJDEP Permit No.	Install Date	TOS (ft. bgs)	BOS (ft. bgs)	Steel Casing (ft. bgs)	Initial Elev. TOS (ft)	Initial Elev. BOS (ft)	Initial Elev. Grnd. (ft)	Initial MPE (ft)
MW-239	2600080794	11/03/06	26.00	31.00	21	-14.30	-19.30	11.70	14.16
MW-243	2600080798	10/25/06	3.50	8.50	N/A	5.81	0.81	9.31	9.08
MW-244	2600080799	11/10/06	32.00	37.00	20	-22.60	-27.60	9.40	9.06

TOS = Top of Screen

BOS = Bottom of Screen

Elev. = Elevation

Grnd. = Ground Surface

MPE = Measuring Point Elevation

N/A = Not Applicable

NF6 Deep Monitoring Well Gauging Results

The deep groundwater contour map generated from the February 2007 site-wide gauging data (Figure 34), indicates that groundwater flow across the NF6 Area is generally north-northeast, towards Woodbridge Creek. Deep groundwater flow across the area occurs within the first water-bearing zone of the native material, and flows under an average gradient of 0.000475.

Two deep monitoring wells (MW-239 and MW-244) were installed within NF6 during the SRFI. Monitoring well MW-239 was paired with previously installed shallow monitoring well RW-42, and MW-244 was paired with shallow monitoring well MW-243, to investigate the hydrogeologic relationship between the first shallow and first native water-bearing zones across the NF6 Area. Vertical hydraulic gradients were calculated for each well pair from the February 2007 gauging data using the USEPA Site Assessment Calculations web-site (2007b), and are included in Appendix F.

A downward vertical gradient of 0.01063 was calculated from deep well MW-239 to shallow well RW-42. Based upon the boring logs from the RW-42 and MW-239 installations, Clay Horizon A was intersected in MW-239 at a depth of 16.8 ft. bgs, but was never encountered in RW-42, which was only advanced to 10.5 ft. bgs. Based on the evidence of an upward vertical gradient between these wells, and the artesian condition found within deep well MW-239, Clay Horizon A appears to be hydraulically isolating the first shallow water-bearing zone from the first native water-bearing zone in this location.

For the well pair MW-243 and MW-244, an upward vertical gradient of 0.03414 was calculated from deep well MW-244 to shallow well MW-243. Based upon the boring logs from the MW-243 and MW-244 installations, Clay Horizon A was intersected at both boring locations. The bottom of the screen in monitoring well MW-243 was placed on top of Clay Horizon A, at a depth of 8.5 ft. bgs, and the top of screen in MW-244 was placed at 32.0 ft. bgs, beneath Clay Horizon A in a red/brown till horizon. Based upon the evidence of an upward vertical gradient between these wells, and the artesian condition found within deep well MW-244, Clay Horizon A appears to be hydraulically isolating the first shallow water-bearing zone from the first native water-bearing zone in this location.

NF6 Deep Monitoring Well Analytical Results

Following groundwater gauging of RW-42 and MW-239, groundwater samples were collected and analyzed for VOCs, SVOCs, and metals on June 12 and May 15, 2007, respectively. Dissolved concentrations of the VOC benzene (3J µg/L) and the SVOC 2,4-dichlorophenol (21 µg/L) were detected in groundwater at RW-42 at concentrations exceeding their respective SRFI Evaluation Criteria (1 µg/L and 20 µg/L, respectively). Only one VOC, bromodichloromethane (2J µg/L), was detected in groundwater from MW-239 at a concentration exceeding the SRFI Evaluation Criteria (1 µg/L). No SVOCs were detected in concentrations exceeding the SRFI Evaluation Criteria in MW-239. The

variation in VOC and SVOC detections between RW-42 and MW-239 provides further evidence of hydraulic isolation between the first shallow water-bearing zone and first native water-bearing zone in this location. The most recent sampling of MW-239 on May 15, 2007 revealed dissolved metals including aluminum, arsenic, total and dissolved iron, manganese, and sodium in concentrations exceeding the SRFI Evaluation Criteria.

The most recent groundwater gauging and sampling of MW-243 and MW-244 was conducted on May 10, 2007. As previously mentioned, dissolved concentrations of VOCs and SVOCs were detected in concentrations exceeding the SRFI Evaluation Criteria in groundwater from MW-243. However, no VOCs or SVOCs were detected in concentrations exceeding the SRFI Evaluation Criteria in MW-244. This provides further evidence of hydraulic isolation between the first shallow water-bearing zone and first native water-bearing zone in this location. Both MW-243 and MW-244 contained metals including total iron, manganese, and sodium in concentrations exceeding the SRFI Evaluation Criteria. Only MW-243 contained exceedances of lead, arsenic, and cobalt. MW-244 also contained aluminum in excess of the SRFI Evaluation Criteria. Appendix G presents all laboratory analytical data for the deep monitoring wells, including metals concentrations, and their respective SRFI Evaluation Criteria.

5.4 SRFI Groundwater Findings – East Yard

5.4.1 AOI 1

AOI 1 Temporary Monitoring Well Installations

Seven of the soil borings in the AOI 1 vicinity were completed as temporary monitoring wells (H0998, H0999, H1000, H1001, H1002, H1017, and H1018) to facilitate the collection of groundwater samples. Seven groundwater grab samples were collected; one from each of the seven temporary groundwater monitoring wells installed in the AOI 1 vicinity. Each sample was analyzed for TCL VOCs +10 via EPA Method SW-846 8260B. Section 4.2.2 provides a description of how these SRFI temporary wells were constructed. None of these temporary monitoring wells were replaced with permanent monitoring wells during the SRFI. Appendix A contains the boring logs for all temporary wells.

AOI 1 Permanent Monitoring Well Installations

Five permanent groundwater monitoring wells (MW-235, MW-236, MW-245, MW-246, and MW-247) were installed in AOI 1 during the SRFI. A soil boring was advanced at each monitoring well location prior to well installation to obtain lithologic and OVM screening data (S2306 at MW-235, S2307 at MW-236, S2308 at MW-245, S2309 at MW-246, and S2310 at MW-247).

Three shallow permanent wells (MW-235, MW-236, and MW-245) were screened in the upper water-bearing zone in the fill. The maximum depth of each borehole ranged from 10.0 ft. bgs (S2308) to 15.0 (S2306) ft. bgs, and five foot screens were set across the

water table at bottom depths ranging from 9.0 ft. bgs (MW-245) to 11.0 ft. bgs (MW-236). Two deep permanent wells (MW-246 and MW-247) were screened in the lower water-bearing zone beneath the fill and Clay Horizon A (see Table 29)

AOI 1 Shallow Permanent Monitoring Well Gauging Results

Site-wide groundwater contour maps from 2003 (see Figure 32) indicate average groundwater flow direction across the entire AOI 1 Area is generally north-northeast, towards Woodbridge Creek. The February 2007 shallow groundwater contour map (see Figure 33) confirms groundwater flow direction is generally north-northeast in this area. The average gradient across the area was calculated to be 0.008166, and average flow direction was north to northeast, based upon data collected during the February 2007 site-wide gauging event.

AOI 1 Temporary Monitoring Well Analytical Results

Four of the seven groundwater grab samples collected from the temporary wells in the AOI 1 vicinity contained concentrations of VOCs in excess of the SRFI Evaluation Criteria. Temporary well H0998, contained benzene (29 µg/L) in excess of the SRFI Evaluation Criterion (1 µg/L), and was collected from a two foot screen interval, set 3.0 to 5.0 ft. bgs. Sample H0999 was collected from temporary well H0999, and contained concentrations of benzene (110 µg/L), cyclohexane (220 µg/L), and methylcyclohexane (140 µg/L), in excess of the SRFI Evaluation Criteria (100 µg/L for both compounds). H0999 was located approximately 80 feet south of H0998, along the State Street property line, and the screened interval was also 3.0 to 5.0 ft. bgs. Sample H1000 contained benzene (400 µg/L) in excess of the SRFI Evaluation Criteria (1 µg/L). Temporary monitoring well H1000 was located approximately 80 feet south of H0999 and 160 feet east of Tank 777. The concentration of methyl tert-butyl ether (MTBE) in sample H1018 (190 µg/L) was in excess of the SRFI Evaluation Criterion (70 µg/L). Temporary monitoring well H1018 was located approximately 200 feet south of H0999. No VOCs were detected in concentrations above the SRFI Evaluation Criteria in samples H1001, H1002, or H1017.

AOI 1 Shallow Monitoring Well Analytical Results

Three new shallow, permanent monitoring wells (MW-235, MW-236, and MW-245) were installed during the SRFI. Following groundwater gauging, a sample was collected from each of these monitoring wells and analyzed for VOCs, SVOCs, and metals. Of the three groundwater samples, only M236A1 contained a VOC (benzene, 13 µg/L) in excess of the SRFI Evaluation Criteria (1 µg/L). Sample M236A1 was collected from MW-236, at a depth of six 6.0 to 11.0 ft. bgs. This sample also contained the only SVOC (2-methylnaphthalene, 130 µg/L) at a concentration exceeding the SRFI Evaluation Criteria (100 µg/L). There were several metals at concentrations exceeding the SRFI Evaluation Criteria for samples collected from MW-235, MW-236, and MW-245. All three monitoring wells had concentrations of iron and manganese exceeding their SRFI Evaluation Criteria. Wells MW-235 and MW-245 contained concentrations of aluminum

Table 29. AOI 1 SRFI Monitoring Well Construction Details

Well ID	Install Date	TOS (ft. bgs)	BOS (ft. bgs)	Steel Casing (ft. bgs)	Elev. TOS (ft)	Elev. BOS (ft)	Grnd. Elev. (ft)	MPE (ft)
MW-235	12/6/06	5.00	10.00	N/A	7.30	2.30	12.30	14.71
MW-236	12/5/06	6.00	11.00	N/A	8.30	3.30	14.30	16.62
MW-245	12/6/06	4.00	9.00	N/A	10.75	5.75	14.75	14.42
MW-246	1/3/07	19.00	24.00	18	-5.50	-10.50	13.50	15.74
MW-247	12/21/06	21.00	26.00	14	-6.60	-11.60	14.40	16.80

TOS = Top of Screen

BOS = Bottom of Screen

Elev. = Elevation

Grnd. = Ground Surface

MPE = Measuring Point Elevation

N/A = Not Applicable

and lead exceeding the SRFI Evaluation Criteria. Wells MW-236 and MW-245 contained concentrations of arsenic and sodium above the SRFI Evaluation Criteria. Additionally, MW-245 contained concentrations of antimony and cobalt above the SRFI Evaluation Criteria. Appendix G presents all laboratory analytical data for the shallow monitoring wells, including dissolved metals concentrations, and their respective SRFI Evaluation Criteria.

AOI 1 Deep Monitoring Well Gauging Results

The deep groundwater contour map generated from the February 2007 site-wide gauging data (Figure 34) indicates that groundwater flow is generally northeast, towards Woodbridge Creek. Deep groundwater flow across the area occurs within the first water-bearing zone of the native material, and flows under an average gradient of 0.00675.

Two deep monitoring wells (MW-246 and MW-247) were installed within AOI 1 during the SRFI. These wells were paired with previously installed shallow wells to investigate the hydrogeologic relationships between the first shallow and first native water-bearing zones across the AOI 1 Area. Vertical hydraulic gradients were calculated from the February 2007 gauging data using the USEPA Site Assessment Calculations website (2007b), and are included in Appendix F.

For the well pair MW-131 and MW-246, a downward vertical gradient of 0.08902 was calculated from shallow well MW-131 to deep well MW-246. Based upon the boring logs from the MW-131 and MW-246 installations, both wells intersect a peat horizon at approximately 12.0 ft. bgs. However, the descriptions of the sediments above and below this peat vary between these two wells. Based upon this variance, and the evidence of a downward vertical gradient between the wells, a degree of hydraulic interconnectivity between the first shallow water-bearing zone and first native water-bearing zone in this location can be inferred.

For the well pair MW-228 and MW-247, a downward vertical gradient of 0.01973 was calculated from shallow well MW-228 to deep well MW-247. Based upon the boring logs from the MW-228 and MW-247 installations, only MW-247 intersects the peat horizon, at approximately 10.0 ft. bgs. In addition, the descriptions of the sediments above and below the peat horizon vary between these two wells. Based upon the discontinuity of the peat, the variance in sediments above and below the peat horizon, and the evidence of a downward vertical gradient between wells, a degree of hydraulic interconnectivity between the first shallow water-bearing zone and first native water-bearing zone in this location can be inferred.

AOI 1 Deep Monitoring Well Analytical Results

Following groundwater gauging of MW-246 and MW-247, a sample was collected from both monitoring wells and analyzed for VOCs, SVOCs, and metals. Despite evidence of hydraulic interconnectivity between water-bearing zones in both the MW-246 and MW-

247 locations, samples from both wells contained no VOCs or SVOCs in concentrations exceeding the SRFI Evaluation Criteria.

Wells MW-246 and MW-247 contained concentrations of dissolved iron, manganese, and sodium exceeding the SRFI Evaluation Criteria. Additionally, MW-247 contained concentrations of aluminum, arsenic, and iron above the SRFI Evaluation Criteria. Appendix G presents all laboratory analytical data for the deep monitoring wells, including metals concentrations, and the respective SRFI Evaluation Criteria.

5.4.2 AOI 2

AOI 2 Temporary Monitoring Well Installations

One of the soil borings in the AOI 2 vicinity was completed as temporary monitoring well H1005 to facilitate the collection of a groundwater sample. This temporary monitoring well was installed by DPT methods and abandoned within 48 hours of installation. Continuous macro-core soil samples were obtained for the entire depth of the pilot boring for lithologic description and OVM screening purposes. Temporary well H1005 was constructed of one-inch diameter PVC riser pipe, with a two foot, 0.01 inch slot, PVC screen. The screen was set across the water table (9.5 to 11.5 ft. bgs) to intersect impacted soil intervals. No sand pack or bentonite seal was used during temporary well installation and the well was not developed prior to sampling. Temporary well H1005 was surveyed as described in the December 2006 SRFI DWP, with no Form A or Form B well completion forms. A detailed boring log for H1005 is included in Appendix A.

A groundwater grab sample was collected from temporary monitoring well H1005 using a dedicated, disposable, 0.5 inch, polyethylene bailer. The groundwater sample was placed in appropriate laboratory cleaned sample containers and packed in a cooler with ice for laboratory submittal. The groundwater sample was analyzed for TCL VOCs +10 via EPA Method SW-846 8260B.

AOI 2 Permanent Monitoring Well Installations

A total of three permanent groundwater monitoring wells (MW-253, MW-254, and MW-255) were installed in AOI 2 during the SRFI. A soil boring was advanced at each monitoring well location prior to well installation to obtain lithologic and OVM screening data (S2316 at MW-253, S2317 at MW-254, and S2318 at MW-255).

Two shallow permanent wells (MW-253 and MW-254) were screened in the upper water-bearing zone in the fill. The maximum depth of each borehole ranged from 10.0 ft. bgs (S2316/MW-253) to 16.0 ft. bgs (S2317/MW-254), and five foot screens were set across the water table with bottom depths ranging from 9.5 ft. bgs (MW-253) to 10.0 ft. bgs (MW-254) (see Table 30).

Table 30. EY AOI #2 - SRFI Monitoring Well Construction Details

Well ID	Install Date	TOS (ft. bgs)	BOS (ft. bgs)	Steel Casing (ft. bgs)	Elev. TOS (ft)	Elev. BOS (ft)	Grnd. Elev. (ft)	MPE (ft)
MW-253	12/8/06	4.50	9.50	N/A	5.64	0.64	10.14	9.75
MW-254	12/8/06	5.00	10.00	N/A	4.73	-0.27	9.73	9.39
MW-255	12/15/06	25.00	30.00	17	-14.22	-19.22	10.78	10.51

TOS = Top of Screen

BOS = Bottom of Screen

Elev. = Elevation

Grnd. = Ground Surface

MPE = Measuring Point Elevation

N/A = Not Applicable

One deep permanent well (MW-255) was screened in the lower water-bearing zone beneath the fill and Clay Horizon A (see Table 30).

AOI 2 Shallow Permanent Monitoring Well Gauging Results

Site-wide groundwater contour maps from 2003 (see Figure 32) indicate average groundwater flow direction across the AOI 2 Area is generally east-northeast, towards Woodbridge Creek. The February 2007 shallow groundwater contour map (see Figure 33) confirms groundwater flow direction is generally east-northeast in this area. The average gradient across the area was calculated to be 0.01212, and average flow direction was to the northeast, based upon data collected during the February 2007 site-wide gauging event.

AOI 2 Temporary Monitoring Well Analytical Results

Temporary well H1005 in AOI 2 contained concentrations of VOCs in excess of the SRFI Evaluation Criteria. Sample H1005 contained benzene (10 µg/L), cyclohexane (590 µg/L), ethylbenzene (780 µg/L), and methylcyclohexane (420 µg/L) in excess of the SRFI Evaluation Criterion (1 µg/L, 100 µg/L, 700 µg/L, and 100 µg/L, respectively), and was collected from a two foot screen interval, set at 9.5 to 11.5 ft. bgs. Temporary monitoring well H1005 was located approximately 40 feet northeast of Tank 760.

AOI 2 Shallow Monitoring Well Analytical Results

Two new shallow, permanent monitoring wells (MW-253 and MW-254) were installed during the SRFI. Following groundwater gauging, a sample was collected from each of these monitoring wells and analyzed for VOCs, SVOCs, and metals.

Groundwater sample M253A1 contained no dissolved VOCs, but contained dissolved SVOCs benzo(a)anthracene (2 µg/L), benzo(a)pyrene (2 µg/L), and benzo(b)fluoranthene (2 µg/L), at concentrations exceeding the SRFI Evaluation Criteria (0.1 µg/L, 0.1 µg/L, and 0.2 µg/L, respectively). Sample M253A1 was collected from MW-253, at a depth of 5.0 to 10 ft. bgs. Groundwater sample M254A1 contained VOC concentrations of benzene (17 µg/L) and methylcyclohexane (170 µg/L) in excess of the SRFI Evaluation Criteria (1 µg/L and 100 µg/L, respectively). This sample contained no SVOC exceedances.

There were metals concentrations exceeding the SRFI Evaluation Criteria in samples collected from MW-253 and MW-254. Samples from both monitoring wells contained concentrations of arsenic, iron, manganese, and sodium exceeding the SRFI Evaluation Criteria. Additionally, groundwater sample M253A1 contained dissolved concentrations of aluminum, cobalt, and nickel above the SRFI Evaluation Criteria. Appendix G presents all laboratory analytical data for shallow monitoring wells MW-253 and MW-254, including dissolved metals concentrations, and their respective SRFI Evaluation Criteria.

AOI 2 Deep Monitoring Well Gauging Results

The deep groundwater contour map generated from the February 2007 site-wide gauging data (Figure 34) indicates that groundwater flow across AOI 2 is generally east-northeast, towards Woodbridge Creek. Deep groundwater flow across the area occurs within the first water-bearing zone of the native material, and flows under an average gradient of 0.00947.

One deep monitoring well (MW-255) was installed within AOI 2 during the SRFI. This well was paired with a previously installed shallow well (MW-149) to investigate the hydrogeologic relationships between the first shallow and first native water-bearing zones across the AOI 2 Area. Vertical hydraulic gradients were calculated from the February 2007 gauging data using the USEPA Site Assessment Calculations website (2007b), and are included in Appendix F.

For the well pair MW-149 and MW-255, a downward vertical gradient of 0.09290 was calculated. Based upon the boring logs from the MW-149 and MW-255 installations, both wells intersect an organic silt horizon with peat and root fragments between 12.0 to 14.0 ft. bgs. The description of the sediments below this interval in MW-255 indicates organic and inorganic silty clay extends to the screen interval, where a medium to coarse sand was intersected. According to the boring log, the well was cased at 17.0 ft. bgs, five feet into the clay horizon. The boring log information suggests that a sufficient confining layer exists between the first shallow water-bearing zone and the first native water-bearing zone. However, the gauging data defines a downward vertical gradient between these wells, suggesting a degree of hydraulic interconnectivity between the two water-bearing zones.

AOI 2 Deep Monitoring Well Analytical Results

Following groundwater gauging of MW-255, a groundwater sample was collected and analyzed for VOCs, SVOCs, and metals. Despite evidence of hydraulic interconnectivity between water-bearing zones in the MW-255 vicinity, the groundwater sample contained no dissolved VOCs or SVOCs at concentrations exceeding the SRFI Evaluation Criteria.

Monitoring well MW-255 contained concentrations of aluminum, iron, manganese, and sodium exceeding the SRFI Evaluation Criteria. Appendix G contains laboratory analytical data for deep monitoring well MW-255, including metals concentrations, and their respective SRFI Evaluation Criteria.

5.4.3 AOI 3

AOI 3 Permanent Monitoring Well Installations

Two permanent groundwater monitoring wells (MW-256 and MW-257) were installed in AOI 3 during the SRFI. A soil boring was advanced at each monitoring well location

prior to well installation to obtain lithologic and OVM screening data (S2319 at MW-256 and S2320 at MW-257).

Two shallow permanent wells (MW-256 and MW-257) were screened in the upper water-bearing zone in the fill as identified by the SAIC Supervisory Geologist. The maximum depth of each borehole ranged from 16.0 ft. bgs (S2319/MW-256) to 10.0 ft. bgs (S2320/MW-257). Five foot screens were set across the water table from 5.0 to 10.0 ft. bgs (see Table 31).

Table 31. AOI 3 SRFI Monitoring Well Construction Details

Well ID	Install Date	TOS (ft. bgs)	BOS (ft. bgs)	Elev. TOS (ft)	Elev. BOS (ft)	Grnd. Elev. (ft)	MPE (ft)
MW-256	12/11/06	5.00	10.00	3.70	-1.30	8.70	11.09
MW-257	12/11/06	5.00	10.00	4.20	-0.80	9.20	11.74

TOS = Top of Screen

BOS = Bottom of Screen

Elev. = Elevation

Grnd. = Ground Surface

MPE = Measuring Point Elevation

AOI 3 Shallow Monitoring Well Gauging Results

Site-wide groundwater contour maps from 2003 (Figure 32) indicate average groundwater flow direction across the AOI 3 Area is generally east-southeast, towards the Arthur Kill. The February 2007 shallow groundwater contour map (see Figure 33) confirms groundwater flow direction is generally east-southeast in this area.

The average gradient across the area was calculated to be 0.008121, and average flow direction was southeast, based upon data collected during the February 2007 site-wide gauging event.

AOI 3 Shallow Monitoring Well Analytical Results

Two new shallow, permanent monitoring wells (MW-256 and MW-257) were installed during the SRFI. Following groundwater gauging, a sample was collected from each of these monitoring wells and analyzed for VOCs, SVOCs, and metals.

Groundwater sample M256A1 from MW-256 contained the VOCs benzene (9 µg/L) and methylcyclohexane (130 µg/L) at concentrations exceeding the SRFI Evaluation Criteria (1 µg/L and 100 µg/L, respectively). In addition, sample M256A1 contained the SVOCs benzo(a)anthracene (3 µg/L), benzo(a)pyrene (3 µg/L), benzo(b)fluoranthene (3 µg/L), benzo(k)fluoranthene (1 µg/L), and indeno(1,2,3-cd)pyrene (1 µg/L) at concentrations exceeding the SRFI Evaluation Criteria (0.1 µg/L, 0.1 µg/L, 0.2 µg/L, 0.5 µg/L, and 0.2 µg/L, respectively). Sample M256A1 was collected from a depth of 5.0 to 10.0 ft. bgs. Groundwater sample M257A1 contained no VOCs or SVOCs in concentrations exceeding the SRFI Evaluation Criteria.

There were several metals in concentrations exceeding the SRFI Evaluation Criteria for samples collected from MW-256 and MW-257. Samples from both monitoring wells contained concentrations of arsenic, iron, lead, manganese, and sodium exceeding the SRFI Evaluation Criteria. Appendix G presents all laboratory analytical data for shallow monitoring wells MW-265 and MW-257, including metals concentrations, and their respective SRFI Evaluation Criteria.

5.4.4 AOC 31

AOC 31 Permanent Monitoring Well Installations

During the SRFI, two permanent monitoring wells (MW-250 and MW-251) were installed in the Tank 772 vicinity to vertically and horizontally delineate the dissolved phase contaminant plume in this area (see Table 32). Shallow monitoring well MW-251 was screened in the fill to horizontally delineate contaminants of concern downgradient of existing shallow well MW-0090 in Tank Basin 772 (see Figure 37, Figure 38, and Figure 40). Deep monitoring well MW-250 was installed adjacent to existing well MW-0090 and screened from 29.0 to 34.0 ft. bgs to vertically delineate the same dissolved phase plume in Tank Basin 772.

Table 32. AOC 31 SRFI Monitoring Well Construction Details

Well ID	Install Date	TOS (ft. bgs)	BOS (ft. bgs)	Elev. TOS (ft)	Elev. BOS (ft)	Grnd. Elev. (ft)	MPE (ft)
MW-250	12/19/06	29.00	34.00	-18.10	-23.10	10.90	13.05
MW-251	12/5/06	5.00	10.00	5.30	0.30	10.30	12.39

TOS = Top of Screen

BOS = Bottom of Screen

Elev. = Elevation

Grnd. = Ground Surface

MPE = Measuring Point Elevation

AOC 31 Shallow Monitoring Well Gauging Results

Site-wide groundwater contour maps from 2003 (Figure 32) indicate average groundwater flow direction across the AOC 31 is generally north to northeast towards the property line. The February 2007 shallow groundwater contour map (see Figure 33) confirmed that groundwater flow direction at AOC 31 is still generally north to northeast in this area. The average gradient across the area was calculated to be 0.00295 from well MW-0090 to MW-9 on Figure 33.

AOC 31 Shallow Monitoring Well Analytical Results

On February 16, 2007, sample M251A1 was collected from MW-251 and analyzed for VOCs, SVOCs, and metals. Sample M251A1 contained no VOCs or SVOCs in concentrations exceeding the SRFI Evaluation Criteria. This sample did, however,

contain metals including aluminum, arsenic, iron, manganese, and sodium in concentrations exceeding the SRFI Evaluation Criteria.

AOC 31 Deep Monitoring Well Gauging Results

The deep groundwater contour map generated from the February 2007 site-wide gauging data (Figure 34) indicates that groundwater flow across AOC 31 is generally to the northeast towards the Arthur Kill. Deep groundwater flow across the area occurs within the first water-bearing zone of the native material, and flows under an average gradient of 0.00344 between deep wells MW-250 and MW-252 on Figure 34.

Deep well MW-250 was paired with a previously installed shallow well (MW-0090) to investigate the hydrogeologic relationships between the first shallow and first native water-bearing zones across the AOI 31 Area. For the well pair MW-250 and MW-90, a downward vertical gradient of 0.01685 was calculated from deep well MW-250 to shallow well MW-0090. Based upon the boring log for MW-250, Clay Horizon A was never encountered; however, red brown clay representing till was intersected at a depth of 12.0 ft. bgs. This clay was not encountered in MW-90, which was advanced to 14.0 ft. bgs. Vertical hydraulic gradients were calculated from the February 2007 gauging data using the USEPA Site Assessment Calculations website (2007b), and are included in Appendix F.

AOC 31 Deep Monitoring Well Analytical Results

Two groundwater samples, M250A1 and M250A2, were collected from MW-250 on February 16 and May 22, 2007, respectively. Both samples were analyzed for VOCs, SVOCs, and metals. Sample M250A1 contained concentrations of VOCs including benzene (180 µg/L) and bromodichloromethane (4 µg/L) exceeding the SRFI Evaluation Criteria (1 µg/L for both compounds). Sample M250A2 contained concentrations of VOCs including benzene (5,800 µg/L), cyclohexane (340 µg/L), and methylcyclohexane (140 µg/L) at concentrations exceeding the SRFI Evaluation Criteria (1 µg/L, 100 µg/L, and 100 µg/L, respectively). The most recent groundwater sample collected from MW-0090 (M090B1) on March 29, 2007 contained concentrations of VOCs including benzene (9,200 µg/L), cyclohexane (510 µg/L), and methylcyclohexane (200 µg/L) in concentrations exceeding the SRFI Evaluation Criteria (1 µg/L, 100 µg/L, and 100 µg/L, respectively). No SVOCs were detected in either MW-250 or MW-0090 in concentrations exceeding the SRFI Evaluation Criteria.

Groundwater from wells MW-250 and MW-0090 contained aluminum, arsenic, iron, manganese, and sodium at concentrations above the SRFI Evaluation Criteria. In addition, the last sample analyzed for metals from MW-0090 contained lead and cobalt at concentrations above the SRFI Evaluation Criteria.

Based upon the analytical data from MW-250, which indicate the presence of dissolved VOCs in concentrations exceeding the SRFI Evaluation Criteria, additional investigation

across the Tank 772 Area will be necessary to obtain full vertical and horizontal contaminant delineation.

5.4.5 SWMU 8

During the SRFI, one permanent deep groundwater monitoring well, MW-252, was installed in the vicinity of SWMU 8 due to the presence of benzene in the existing shallow wells and its proximity to the property line and the Arthur Kill. An SRFI soil boring (S2315) was advanced at the MW-252 monitoring well location prior to well installation to obtain lithologic and OVM screening data. Following lithologic and OVM data collection, a deep monitoring well was installed in the soil boring.

The steel casing for deep monitoring well MW-252 was set six feet into a clay confining layer, encountered at 8.0 ft. bgs. The PVC screen was set from 25.0 to 30.0 ft. bgs. Following groundwater gauging, a sample was collected from MW-252 on February 15, 2007, and analyzed for VOCs, SVOCs, and metals.

MW-252 was paired with a previously installed shallow well (MW-132) to investigate the hydrogeologic relationships between the first shallow and first native water-bearing zones across the SWMU 8 Area.

For the well pair MW-252 and MW-132, a downward vertical gradient of 0.07407 was calculated, from shallow well MW-132 to deep well MW-252. Based upon the boring logs from the MW-252 and MW-132 installations, both MW-132 and MW-252 intersect a peat horizon (Clay Horizon A), between 12.0 to 15.0 ft. bgs. The evidence of a downward vertical gradient between wells is suggestive of hydraulic interconnectivity between the first shallow water-bearing zone and first native water-bearing zone. However, the continuity of Clay Horizon A in both borings, coupled with the analytical data presented below, indicates that hydraulic isolation between the two water-bearing zones is more likely.

SWMU 8 Deep Monitoring Well Analytical Results

Following groundwater gauging of MW-252 and MW-132, a sample was collected from both monitoring wells and analyzed for VOCs, SVOCs, and metals. Despite possible evidence of hydraulic interconnectivity between water-bearing zones in the MW-252 and MW-132 locations, only sample M132A9 collected on April 11, 2007 contained concentrations of VOCs 1,2-dichloropropane (2J µg/L), benzene (570 µg/L), cyclohexane (290 µg/L), and methylcyclohexane (250 µg/L); and SVOCs 2,4-dimethylphenol (180 µg/L), 2-methylnaphthalene (160 µg/L), and bis(2-ethylhexyl)phthalate (14 µg/L) at concentrations exceeding the SRFI Evaluation Criteria. Sample M252A1, collected on February 15, 2007, contained no VOCs or SVOCs in concentrations exceeding the SRFI Evaluation Criteria, providing further evidence of hydraulic isolation between the first shallow water-bearing zone, and the first native water-bearing zone in this vicinity.

Several dissolved metals were detected in samples M132A9 and M252A1 at concentrations exceeding the SRFI Evaluation Criteria (arsenic, iron, manganese, and sodium) during the most recent sampling events (April 11, 2007 and February 15, 2007 respectively). In addition, sample M132A9 contained lead at a concentration exceeding the SRFI Evaluation Criterion.

5.4.6 MW-6 Vicinity

MW-6 Vicinity Temporary Monitoring Well Analytical Results

Two temporary monitoring wells (H1003 and H1004) were installed in the vicinity of MW-6 along the Asarco property boundary in the southern portion of the EY. Temporary well H1004 was installed within 10 feet of MW-6, and was advanced to a depth of 20.0 ft. bgs. No OVM readings above 0 ppm were recorded at this location, and the temporary well screen was set between 10.0 and 12.0 ft. bgs. A groundwater grab sample, H1004, was collected on December 15, 2006 and analyzed for VOCs. Dissolved benzene (4 µg/L) was detected at a concentration exceeding the SRFI Evaluation Criteria (1 µg/L), thus confirming groundwater contamination within the vicinity of MW-6.

Temporary monitoring well H1003 was located approximately 100 feet east and sidegradient to H1004, and was advanced to a depth of 20.0 ft. bgs. No OVM readings above 0 ppm were observed at this location, and the temporary well screen was set between 16.0 to 18.0 ft. bgs. A groundwater grab sample, H1003, was collected on December 15, 2006 and analyzed for VOCs. No VOCs were detected in concentrations exceeding the SRFI Evaluation Criteria. A groundwater contour map incorporating gauging data from these temporary monitoring wells is included as Figure 33. Based on the installation and analytical data collected from H1003 and H1004, dissolved phase contamination appears to be limited in aerial extent surrounding MW-6 and H1004 (see Figure 37).

5.4.7 SWMU 36 Vicinity

During the SRFI, two temporary wells (H1007 and H1019) were installed in the vicinity of boring S1421 where a petroleum sheen and odor was previously identified (see Figure 19). Since the groundwater sample from H1007 was not filtered for metals prior to laboratory analysis, Chevron installed H1019 adjacent to H1007 and collected a metals sample using porous media (see Section 4.2.2). Appendix G presents all laboratory analytical data for all temporary and permanent groundwater monitoring wells, including dissolved metals concentrations, and their respective SRFI Evaluation Criteria.

On December 13, 2007, a groundwater grab sample was collected at temporary well H1007 from 4.0 to 6.0 ft bgs, and analyzed for VOCs, SVOCs, and metals. No VOCs or SVOCs were detected in concentrations exceeding the SRFI Evaluation Criteria. In addition, no benzene was detected above the MDL of 0.5 µg/L. Figure 37 depicts the distribution of benzene in groundwater at SWMU 36. Several dissolved metals were

detected at concentrations exceeding the SRFI Evaluation Criteria; however, sample H1007 was not collected from porous media for metals prior to laboratory analysis.

Accordingly, Chevron collected a groundwater sample for TAL metals analysis from H1019 on January 9, 2007 that was properly collected using porous media as described in Section 4.2.2. The well was screened from 3.0 to 6.0 ft bgs across the water table. The only exceedance for metals that was not aluminum, iron, or manganese was cobalt. The cobalt value of 5.5 µg/L was slightly above the RFI Evaluation Criteria of 5 µg/L.

Chevron believes there is adequate number of wells (e.g., SB-14, SB-17, MW-150, etc.) in this area and additional wells are not needed. Chevron plans to continue monitoring COCs in this area and report the findings to EPA and NJDEP.

5.4.8 AOC 13 Vicinity

SRFI investigative work was conducted in the AOC 13 vicinity to characterize potential benzene contamination of groundwater in this area. During the SRFI, one temporary monitoring well, H1006, was installed in the vicinity of AOC 13 using the decision-based sampling and analysis strategy as detailed in the October 2006 SRFI DWP (see Figure 13). A groundwater grab sample was collected from the 7.5 to 9.5 ft. bgs interval, and analyzed for VOCs. Dissolved concentrations of benzene (28 µg/L), chlorobenzene (560 µg/L), and chloroethane (110 µg/L) were detected in concentrations exceeding the SRFI Evaluation Criteria (1 µg/L, 50 µg/L, and 100 µg/L, respectively). The presence of dissolved contaminants in this area is confirmed; however, no further horizontal delineation of dissolved or adsorbed contamination can be conducted in this area due to the proximity of the bulkhead. Figure 37 depicts the distribution of benzene in groundwater at AOC 13.

5.5 NF/MY SRFI MIP Surveys

To optimize the placement of additional monitoring wells and soil sampling locations, a MIP survey was conducted in three AOIs (AOI NF2, AOI NF5, and AOI NF6) in the NF/MY. Table 33 summarizes all eighteen MIP surveys and relative confirmation soil samples. Figure 4 depicts the location of all MIP points in the NF/MY. The boring/MIP logs for all these locations is contained in Appendix C.

One traverse consisted of 10 MIP points along the southern shore of Woodbridge Creek between existing permanent monitoring wells MW-126 and MW-136 in AOI NF5. Six of these 10 MIP points were focused on two historically filled stream channels to determine if VOCs were present (see Figure 4).

In the case of historical or paleo-stream channels in the NF that once led to the Woodbridge Creek, VOC detections were minimal. Based on the confirmatory soil samples, they were most likely more reflective of the natural organic material associated with the peat layer in Clay Horizon A. The MIP and corresponding soil confirmation data indicated no concerns or findings that would lead Chevron to install additional

Table 33. SRFI MIP Survey Summary

MIP/Boring ID	AOI	Total Depth of Survey (ft. bgs)	Confirmation Soil Samples		
			Sample ID	SRFI Exceedances	Sample Interval (ft. bgs)
S2090	NF5	26.0	S2090D4	NE	7.5-8.0
			S2090I4	NE	17.5-18.0
			S2090M2	NE	24.5-25.0
S2091	NF5	26.0	S2091E3	NE	9.0-9.5
			S2091G2	NE	12.5-13.0
			S2091J4	NE	18.5-19.0
S2092*	NF5	22.0	NA		
S2093	NF5	30.0	S2093E4	NE	9.5-10.0
			S2093I4	NE	17.5-18.0
S2094*	NF5	27.0	NA		
S2095*	NF5	30.0	NA		
S2096*	NF5	20.2	NA		
S2097*	NF5	26.0	S2097G1	NE	12.0-12.5
			S2097I4	NE	17.5-18.0
S2098*	NF5	29.0	NA		
S2099	NF5	23.5	NA		
S2100	NF6	20.0	S2100G4	Benzene (16 mg/kg)	13.5-14.0
			S2100K1	NE	19.5-20.0
S2101	NF2	17.8	S2101A4	NE	1.5-2.0
			S2101G1	NE	12.0-12.5
S2102	NF2	14.0	S2102B2	NE	2.5-3.0
			S2102H2	NE	14.5-15.0
S2103	NF2	14.1	S2103B3	NE	3.0-3.5
			S2103H2	NE	14.5-15.0
S2104	NF2	20.8	NA		
S2105	NF2	18.2	S2105F3	NE	11.0-11.5
			S2105G4	NE	13.5-14.0
S2106	NF2	14.1	S2106B2	NE	2.0-2.5
			S2106H2	NE	14.5-15.0
S2107	NF2	17.3	S2107E1	Benzene (1.1 mg/kg)** Xylene (68 mg/kg)**	8.5-9.0
			S2107H2	NE	14.5-15.0

NA = Not Analyzed/MIP Profile Only

NE = No Exceedances

*Indicates MIP point associated with historical stream channel location (see Figure 4).

** Exceeds SRFI Evaluation Criteria only; does not exceed NJDEP NRDCSCC.

groundwater (shallow or deep) monitoring wells along the NF boundary with the Woodbridge Creek. However, Chevron did install one deep well (MW-237) adjacent to existing shallow well MW-136 to confirm (see Section 5.3.2). Existing shallow Sentinel monitoring wells (MW-031, MW-032, MW-033, MW-124, MW-126, and MW-136) along this traverse have no history of exceedances of the SRFI Evaluation Criteria for VOCs (see Appendix G).

In addition, seven MIP points were advanced at AOI NF2 and one MIP Point at AOI NF6. As shown in Table 33, two of these sample locations (S2100G4 at NF6 and S2107E1 at NF2) contained exceedances of the SRFI Evaluation Criteria. Sample S2100G4 (benzene, 16 mg/kg), was collected at a depth of 13.5 feet bgs from a soft moist peat with a slight petroleum odor. Sample S2107E1 (benzene, 1.1 mg/kg and xylene, 68 mg/kg) was collected at a depth of 8.5 feet bgs from a loose, wet olive brown medium sand with a little gray clay. No peat layer was encountered at boring S2107.

Overall, the MIP data correlated very well with the soil boring logs and soil sample analytical results. The MIP conductivity log accurately depicted the stratigraphic contacts of interest (e.g., fill/peat boundaries).

6. RFI Letter Responses

6.1 Comment 1

RFI Section: General

Comment Letter Page: 1

It should be noted that the Full RCRA Facility Investigation Report Documents the investigation of the Solid Waste Management Units and Areas of Concern (AOCs) contained in North Field/Main Yard, East Yard and Central Yard only. It does not include those SWMUs and AOCs within the West Yard, Amboy Field, or the North Field Extension. In addition the RFI Report does not address Potential Areas of Concern identified separately by the NJDEP.

Chevron Response

Chevron acknowledges NJDEP's comment. SWMUs and AOCs in the West Yard (WY), Amboy Field (AF), and North Field Extension (NFE) have been investigated separately. The WY and AF have been investigated under a Memorandum of Agreement with the NJDEP as part of the City of Perth Amboy's Brownfields Redevelopment Project. The NFE has not been used by the Refinery and has been undergoing separate investigations as part of an ongoing litigation matter. The following relevant investigation and remediation reports have been submitted to EPA and NJDEP:

- West Yard Project
 - Remedial Investigation Report (2000);
 - Remedial Action Work Plans (2003); and
 - Remedial Action Report (2003).
- Amboy Field Project
 - Site/Remedial Investigation Report (2003); and
 - Remedial Action Report (2005).
- North Field Extension Project
 - Remedial Investigation Report (2007).

The Final Remedial Action Report for the WY is currently being prepared and will be submitted to the NJDEP for review and approval in early 2008. The Remedial Action Reports for AF have been submitted and are pending approval by the NJDEP. For groundwater in the WY above the NJDEP GWQS, a Classification Exception Area (CEA) was submitted in 2005 that addresses ammonia, metals, and sulfate. A CEA, also submitted in 2005, is proposed for AF for semi-volatile organic compounds, metals, and ammonia.

The WY was sold by Chevron in 2004 and was redeveloped as part of the City of Perth Amboy's Brownfields Redevelopment Project. AF was sold by Chevron in November 2005 and is currently being redeveloped.

The NFE is a separate and vacant parcel of land, never developed by Chevron. Several historic SWMUs and AOCs unrelated to Chevron activities exist on the property. Chevron is attempting to settle remedial responsibility issues with the former owners/responsible parties. Due to litigation between the parties, the investigation of the NFE has been conducted separately. Recent remedial investigation conducted at the NFE was submitted to EPA and NJDEP for review on July 30, 2007. Future investigation and remediation of this property will be addressed separately from Chevron's RCRA Corrective Action Program by the new owners of the property.

All currently identified PAOCs on the active Refinery parcels have also been addressed separately from the RFI Report submitted in 2003. A PAOC Report was submitted to EPA and NJDEP in June 2007. This PAOC Report was prepared in accordance with the requirements for Site Investigation by NJDEP. The primary goal of Chevron's PAOC effort was to identify and assess units of environmental concern (as described by NJAC 7:26E) which were not already identified in Chevron's active HSWA Permit.

6.2 Comment 2

RFI Section: General

Comment Letter Page: 1

Vertical delineation of contamination has not been completed. There are areas across the site where the fill layer is in contact with sandy till or other sandy units. In these areas there appears to be a downward vertical gradient. Chevron shall determine the vertical hydraulic gradients at the site through the installation of deep monitor wells. Chevron shall delineate the vertical extent of ground water contamination at the site.

Chevron Response

Chevron's early conceptual site model included the presence of a shallow impermeable clay layer under most of the site. This model has been supported in many of the samples collected during the RFI; however Chevron acknowledged the need to gain additional information to further support this model during the SRFI. In pursuit of this, Chevron installed 10 additional deep wells screened in the first water-bearing zone beneath the fill/native interface to supplement the existing groundwater monitoring network and fill any data gaps concerning vertical groundwater delineation as part of the SRFI discussed previously in Section 5.3. Each of the 10 deep permanent SRFI monitoring wells were screened in the lower water-bearing zone beneath the fill and Clay Horizon A (see Table 34). Five deep monitoring wells (MW-237, MW-238, MW-239, MW-240, and MW-244) were installed in the MY between October and November 2006. Another five deep monitoring wells (MW-246, MW-247, MW-250, MW-252, and MW-255) were installed in the EY between December 2006 and January 2007.

The location and screen depth of each SRFI shallow and deep well was selected by Chevron to determine the horizontal and vertical extent of contamination and to have a better understanding of the site's hydrogeology. SRFI shallow wells were located in areas of the site where additional data was deemed necessary. SRFI deep wells were located in known areas of the site where benzene contamination was highest in existing shallow wells to see if existing plumes were sinking below the existing monitoring well network. In addition, SRFI deep wells were located near environmentally sensitive areas along the Woodbridge Creek and the Arthur Kill and in some cases along the property border. Furthermore, SRFI deep wells were located in each yard to determine the horizontal and vertical hydraulic gradients across the site.

Prior to the SRFI, twelve deep monitoring wells and three deep piezometers existed on-site as depicted in Table 35. Nine of these deep wells were installed prior to the 2006 SRFI and after the submittal of the RFI Report in November 2003. Seven of these nine deep wells were installed in the MY in 2004. The remaining two deep wells (MW-184 and MW-185) were installed in the CY in 2004 during the AOC 36 – Chlorinated Plume Investigation (Chevron, 2005). An analysis of these two deep wells located in the CY is not discussed in this response. These findings are presented in the AOC 36 Investigation Report. One deep well (MW-178) was installed in the EY during the RFI, while another

Table 34. SRFI Deep Monitoring Well Construction Details

Well ID	Yard	Install Date	TOS (ft. bgs)	BOS (ft. bgs)	Steel Casing (ft. bgs)	Elev. TOS (ft)	Elev. BOS (ft)	Grnd. Elev. (ft)	MPE (ft)
MW-237	MY	10/30/06	22.00	27.00	21.00	-16.00	-21.00	6.00	8.65
MW-238	MY	11/7/06	20.00	25.00	19.00	-15.30	-20.30	4.70	6.78
MW-239	MY	11/3/06	26.00	31.00	21.00	-14.30	-19.30	11.70	14.16
MW-240	MY	10/31/06	22.00	27.00	20.50	-8.22	-13.22	13.78	13.46
MW-244	MY	11/10/06	32.00	37.00	20.00	-22.60	-27.60	9.40	9.06
MW-246	EY	1/3/07	19.00	24.00	18.00	-5.50	-10.50	13.50	15.74
MW-247	EY	12/21/06	21.00	26.00	14.00	-6.60	-11.60	14.40	16.80
MW-250	EY	12/19/06	29.00	34.00	18.00	-18.10	-23.10	10.90	13.05
MW-252	EY	12/13/06	25.00	30.00	14.00	-15.69	-20.69	9.31	8.90
MW-255	EY	12/15/06	25.00	30.00	17.00	-14.22	-19.22	10.78	10.51

TOS = Top of Screen

BOS = Bottom of Screen

Elev. = Elevation

Grnd. = Ground Surface

MPE = Measuring Point Elevation

Table 35. Pre-SRFI Deep Monitoring Well/Piezometer Construction Details

Well ID	Yard	Install Date	TOS (ft. bgs)	BOS (ft. bgs)	Steel Casing (ft. bgs)	Elev. TOS (ft)	Elev. BOS (ft)	Grnd. Elev. (ft)	MPE (ft)
MW-115	MY	7/18/02	17.00	22.00	None	-2.72	-7.72	14.28	14.01
MW-178	EY	3/18/03	15.25	25.25	15.00	-0.25	-10.25	15.00	17.38
MW-184	CY	1/6/04	21.00	26.00	19.00	12.58	7.58	33.58	33.01
MW-185	CY	1/7/04	34.00	39.00	30.00	-0.30	-5.30	33.70	33.38
MW-187	MY	3/30/04	29.00	34.00	29.00	-21.80	-26.80	7.20	9.70
MW-196	MY	10/14/04	23.00	28.50	15.50	-13.56	-19.06	9.44	9.44
MW-198	MY	10/15/04	23.00	28.50	14.00	-13.29	-18.79	9.71	9.71
MW-200	MY	10/11/04	29.00	34.50	18.00	-17.15	-22.65	11.85	14.35
MW-202	MY	10/12/04	34.50	40.00	21.00	-22.55	-28.05	11.95	14.45
MW-204	MY	11/8/04	33.50	38.50	17.00	-22.17	-27.17	11.33	13.83
MW-206	MY	10/13/04	23.50	29.00	16.00	-12.64	-18.14	10.86	13.34
P-7*	EY	10/23/91	23.00	28.00	None	0.72	-4.28	23.72	23.59
P-9*	MY	10/18/91	23.00	28.00	None	-8.90	-13.90	14.10	16.95
P-10*	MY	10/12/91	23.50	28.50	None	-15.87	-20.87	7.63	10.25
SB-10	EY	11/5/81	9.75	19.75	None	-8.44	-18.44	1.31	3.11

TOS = Top of Screen

BOS = Bottom of Screen

Elev. = Elevation

Grnd. = Ground Surface

MPE = Measuring Point Elevation

*Piezometer

deep well (SB-10) was installed over twenty years before the RFI in 1981. The three deep piezometers (P-7, P-9, and P-10) were installed in 1991 and have only been used for gauging purposes and were never sampled.

As of this report, 22 deep monitoring wells and three deep piezometers exist on-site. A deep groundwater contour map generated from the February 2007 site-wide gauging data utilizing most of these wells is depicted in Figure 34.

The following is a discussion of the vertical hydraulic gradients and vertical extent of groundwater contamination as defined by these deep wells and piezometers. Table 36 contains construction details and vertical gradient data for each shallow/deep well pair investigated during the SRFI. The vertical hydraulic gradient was calculated from the February 2007 gauging data using the USEPA Site Assessment Calculations web site, and is included in Appendix F.

Table 36. SRFI Deep/Shallow Well Construction and Vertical Gradient Data

Well ID	Shallow Or Deep	Grnd. Elev. (ft)	TOS (ft. bgs)	Screen Length (ft)	DTW (ft. bgs)	Vert. Grad. Btwn. Wells	Flow Dir. Btwn. Wells
MW-136	Shallow	5.80	1.00	10.0	1.73	0.07548	Down
MW-237	Deep	6.00	22.00	5.0	3.50		
MW-0060	Shallow	11.95	2.00	10	4.71	0.1620	Down
MW-200	Deep	11.85	29.00	5.5	9.02		
MW-205	Shallow	11.80	3.50	5.5	5.62	0.1275	Down
MW-206	Deep	10.86	23.50	5.5	7.35		
MW-197	Shallow	9.39	3.50	7.0	5.21	0.1173	Down
MW-198	Deep	9.71	23.00	5.5	7.78		
MW-141	Shallow	14.50	4.00	10.0	5.42	0.03628	Down
MW-178	Deep	15.00	15.25	10.0	6.31		
SB-15	Shallow	5.98	2.00	10.0	2.33	0.3889	Down
SB-10	Deep	1.31	9.75	10.0	2.49		
MW-195	Shallow	8.97	2.00	5.0	3.86	0.1705	Down
MW-196	Deep	9.44	23.00	5.5	7.83		
MW-101	Shallow	33.44	7.00	10.0	15.20	0.6364	Down
MW-184	Deep	33.58	21.00	5.0	24.16		
MW-186	Shallow	33.74	2.00	10.0	1.73	0.5016	Down
MW-185	Deep	33.70	34.00	5.0	17.76		
MW-114	Shallow	14.16	2.00	10.0	5.94	0.1263	Up
MW-115	Deep	14.28	17.00	5.0	4.18		
RW-02	Shallow	13.80	3.00	10.0	6.41	0.1409	Up
MW-240	Deep	13.78	22.00	5.0	3.71		
NF-10	Shallow	7.08	3.00	10.0	1.43	0.03594	Down
MW-187	Deep	7.20	29.00	5.0	2.48		
MW-117	Shallow	4.40	1.00	10.0	0.71	0.1112	Up

Table 36. SRFI Deep/Shallow Well Construction and Vertical Gradient Data

Well ID	Shallow Or Deep	Grnd. Elev. (ft)	TOS (ft. bgs)	Screen Length (ft)	DTW (ft. bgs)	Vert. Grad. Btwn. Wells	Flow Dir. Btwn. Wells
MW-238	Deep	4.70	20.00	5.0	-1.07		
MW-243	Shallow	9.31	3.50	5.0	4.06	0.03414	Up
MW-244	Deep	9.40	32.00	5.0	3.18		
MW-131	Shallow	13.80	2.00	10.0	3.85	0.08902	Down
MW-246	Deep	13.50	19.00	5.0	5.09		
MW-228	Shallow	13.65	2.00	10.0	4.56	0.01973	Down
MW-247	Deep	14.40	21.00	5.0	5.67		
MW-90	Shallow	10.60	2.00	10.0	6.33	0.01685	Down
MW-250	Deep	10.90	29.00	5.0	7.08		
MW-132	Shallow	9.45	3.00	12.00	5.68	0.07407	Down
MW-252	Deep	9.31	25.00	5.0	7.18		
MW-149	Shallow	10.74	3.00	10.0	7.11	0.09290	Down
MW-255	Deep	10.78	25.00	5.0	9.19		
RW-42	Shallow	12.10	1.00	9.0	3.54	0.01063	Down
MW-239	Deep	11.70	26.00	5.0	3.41		
MW-6	Shallow	23.30	5.00	15.0	8.90	0.1911	Down
P-7	Deep	23.72	23.00	5.0	12.68		

Grnd. Elev. = Ground Elevation

TOS = Top of Screen

DTW = Depth to Water

Vert. Grad. Btwn. Wells = Vertical Gradient Between Wells

Flow Dir. Btwn. Wells = Flow Direction Between Wells

Table 37 through Table 39 contains a summary of the analytical history and SRFI Evaluation Criteria exceedances for each shallow/deep well pair investigated during the SRFI. Due to their common occurrence on-site, Chevron has chosen not to exhibit or discuss SRFI Evaluation Criteria exceedances for aluminum, iron, and manganese in this comment response. Appendix G presents all laboratory analytical data for the deep monitoring wells, including dissolved metals concentrations, and their respective SRFI Evaluation Criteria.

Vertical Delineation Findings

North Field/Main Yard Area

SWMU 1 – North Field Basin

Two deep permanent groundwater monitoring wells (MW-196 and MW-198) were installed around SWMU 1 in 2004 after the RFI as part of the North Field Basin (NFB) Closure Project. They were both screened in the first native water-bearing zone beneath the fill and Clay Horizon A (see Table 15).

Table 37. Deep Well Pairs – VOC Exceedances

Well ID	Unit	Type	Years Sampled	# of Rnds.	Parameter/SRFI Evaluation Criteria ¹																
					Benzene 1 mg/L	Bromodichloromethane 1 µg/L	Chlorobenzene 50 µg/L	Cyclohexane 100 µg/L	Dibromochloromethane 1 µg/L	Ethylbenzene 700 µg/L	1,2-Dichloroethane 2 µg/L	1,1-Dichoroethylene 1 µg/L	1,2-Dichloropropane 1 µg/L	Methylcyclohexane 100 µg/L	Methyl Tert-Butyl Ether 70 µg/L	p-Dichlorobenzene 75 µg/L	Tetrachloroethylene 1 µg/L	1,1,2-Trichloroethane 3 µg/L	Trichloroethylene 1 µg/L	Vinyl Chloride 1 µg/L	Xylene 1000 µg/L
Main Yard																					
MW-3	MY	S	2002-2007	8	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
P-9	MY	D	NS	0	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
MW-5	MY	S	1995-2007	12	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
P-10	MY	D	NS	0	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
RW-42	AOC 8	S	2002-2007 ³	4	ND-220	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
MW-239	AOC 8	D	2006-2007	2	NE	2J-6	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
RW-02	NF2 LNAPL	S	2003-2007	7	88-190	NE	NE	57-180	NE	NE	NE	NE	NE	85-270	NE	NE	NE	NE	NE	NE	NE
MW-240	NF2 LNAPL	D	2006-2007	2	NE	ND-6	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
MW-195	SWMU 1	S	2004-2007	11	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
MW-196	SWMU 1	D	2004-2007	11	ND-16	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
MW-197	SWMU 1	S	2004-2007	11	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
MW-198	SWMU 1	D	2004-2007	10	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
None ²	SWMU 2	S	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
MW-202	SWMU 2	D	2004-2007	11	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
MW-0060	SWMU 2	S	2006-2007	3	48-69	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
MW-200	SWMU 2	D	2004-2007	11	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
None ²	SWMU 2	S	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table 37. Deep Well Pairs – VOC Exceedances

Well ID	Unit	Type	Years Sampled	# of Rnds.	Parameter/SRFI Evaluation Criteria ¹																
					Benzene 1 mg/L	Bromodichloromethane 1 µg/L	Chlorobenzene 50 µg/L	Cyclohexane 100 µg/L	Dibromochloromethane 1 µg/L	Ethylbenzene 700 µg/L	1,2-Dichloroethane 2 µg/L	1,1-Dichloroethylene 1 µg/L	1,2-Dichloropropane 1 µg/L	Methylcyclohexane 100 µg/L	Methyl Tert-Butyl Ether 70 µg/L	p-Dichlorobenzene 75 µg/L	Tetrachloroethylene 1 µg/L	1,1,2-Trichloroethane 3 µg/L	Trichloroethylene 1 µg/L	Vinyl Chloride 1 µg/L	Xylene 1000 µg/L
MW-204	SWMU 2	D	2004-2007	11	NE	ND-7	NE	NE	ND-3J	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
MW-205	SWMU 2	S	2004-2007	11	7-70	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
MW-206	SWMU 2	D	2004-2007	11	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
MW-243	SWMU 16	S	2006-2007	2	2300-4000	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
MW-244	SWMU 16	D	2006-2007	2	NE	ND-5J	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
MW-117	SWMU 18	S	2002-2007	10	700-1900	NE	NE	NE	NE	NE	NE	NE	NE	NE	100-240	NE	NE	NE	NE	NE	NE
MW-238	SWMU 18	D	2006-2007	2	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
NF-10	SWMU 20	S	2002-2007	18	48-790	NE	NE	240-340	NE	NE	NE	NE	NE	140-240	NE	NE	NE	ND-7J	NE	NE	230-1800
MW-187	SWMU 20	D	2004	1	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
MW-114	SWMU 28	S	2002-2007	10	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
MW-115	SWMU 28	D	2002-2003	3	NE	ND-6	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
MW-136	SWMU 41	S	2002-2007	8	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
MW-237	SWMU 41	D	2006-2007	3	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE

Table 37. Deep Well Pairs – VOC Exceedances

Well ID	Unit	Type	Years Sampled	# of Rnds.	Parameter/SRFI Evaluation Criteria ¹																
					Benzene 1 mg/L	Bromodichloromethane 1 µg/L	Chlorobenzene 50 µg/L	Cyclohexane 100 µg/L	Dibromochloromethane 1 µg/L	Ethylbenzene 700 µg/L	1,2-Dichloroethane 2 µg/L	1,1-Dichloroethylene 1 µg/L	1,2-Dichloropropane 1 µg/L	Methylcyclohexane 100 µg/L	Methyl Tert-Butyl Ether 70 µg/L	p-Dichlorobenzene 75 µg/L	Tetrachloroethylene 1 µg/L	1,1,2-Trichloroethane 3 µg/L	Trichloroethylene 1 µg/L	Vinyl Chloride 1 µg/L	Xylene 1000 µg/L
East Yard																					
MW-6	EY	S	2002-2007	9	2J-47	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	
P-7	EY	D	NS	0	NS	NS	NS	NS	NE	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	
MW-149	EY	S	2002-2007	9	ND-200	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	
MW-255	EY	D	2007	1	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	
MW-90	AOC 31	S	2003-2007	10	2500-13000	NE	NE	420-640	NE	560-1200	NE	NE	NE	ND-270	NE	NE	ND-24J	NE	NE	NE	
MW-250	AOC 31	D	2007	2	180-5800	ND-4J	NE	58-340	NE	NE	NE	NE	NE	23-140	NE	NE	NE	NE	NE	NE	
MW-132	SWMU 8	S	2002-2007	8	640-1300	NE	32-580	150-300	NE	NE	NE	NE	ND-2J	53-270	NE	ND-250	NE	NE	NE	480-2500	
MW-252	SWMU 8	D	2007	1	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	
MW-141	SWMU 9	S	2002-2007	9	ND-29	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	
MW-178	SWMU 9	D	2003	2	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	
MW-131	SWMU 10	S	2002-2007	14	120-1100	NE	NE	20-150	NE	NE	ND-24	NE	NE	NE	NE	NE	NE	NE	NE	ND-4J	
MW-246	SWMU 10	D	2007	1	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	
SB-15	SWMU 25	S	2002-2007	15	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	
SB-10	SWMU 25	D	2004	1	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	
MW-228	SWMU 42	S	2005-2007	2	3J	NS	NE	NS	NE	NE	NS	NS	NS	NS	NS	NE	NE	NS	NS	NS	
MW-247	SWMU 42	D	2007	1	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	

Table 37. Deep Well Pairs – VOC Exceedances

Well ID	Unit	Type	Years Sampled	# of Rnds.	Parameter/SRFI Evaluation Criteria ¹																
					Benzene 1 mg/L	Bromodichloromethane 1 µg/L	Chlorobenzene 50 µg/L	Cyclohexane 100 µg/L	Dibromochloromethane 1 µg/L	Ethylbenzene 700 µg/L	1,2-Dichloroethane 2 µg/L	1,1-Dichloroethylene 1 µg/L	1,2-Dichloropropane 1 µg/L	Methylcyclohexane 100 µg/L	Methyl Tert-Butyl Ether 70 µg/L	p-Dichlorobenzene 75 µg/L	Tetrachloroethylene 1 µg/L	1,1,2-Trichloroethane 3 µg/L	Trichloroethylene 1 µg/L	Vinyl Chloride 1 µg/L	Xylene 1000 µg/L
Central Yard																					
MW-186	AOC 36	S	2004-2006	10	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
MW-185	AOC 36	D	2005-2006	6	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
MW-101	SWMU 34	S	2002-2006	11	36-78	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
MW-184	SWMU 34	D	2005-2006	6	ND-4J	NE	NE	NE	NE	NE	NE	ND-13	NE	NE	NE	NE	NE	NE	NE	ND-37	33-65

¹Detection range provided only where exceedances were found. Otherwise, "NE" is designated.²No shallow well pair in this area.³No sample collected in 2006.

Values in bold indicate one or more deep well exceedances.

S = Shallow Well

D = Deep Well

NE = No Exceedances

ND = Non-Detect

NS = Not Sampled

N/A = Not Applicable

Table 38. Deep Well Pairs – SVOC Exceedances

Well ID	Unit	Type	Years Sampled	# of Rnds.	Parameters/SRFI Evaluation Criteria ¹																
					Benzo(a)anthracene 0.1 µg/L	Benzo(a)pyrene 0.1 µg/L	Benzo(b)fluoranthene 0.2 µg/L	Bis(2-ethylhexyl)phthalate 3 µg/L	Caprolactam 100 µg/L	Chrysene 5 µg/L	Dibenzo(a,h)anthracene 0.3 µg/L	2,4-Dichlorophenol 20 µg/L	2,4-Dimethylphenol 100 µg/L	Indeno(1,2,3-cd)pyrene 0.2 µg/L	2-Methylnaphthalene 100 µg/L	Naphthalene 300 µg/L	o-Cresol 100 µg/L	p-Cresol 100 µg/L	PCP 0.3 µg/L	Phenanthrene 100 µg/L	Phenol 2000 µg/L
Main Yard																					
None ²	MY	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
MW-202	MY	D	2004-2007	11	NE	NE	NE	ND-4J	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
None ²	MY	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
MW-204	MY	D	2004-2007	11	NE	NE	NE	ND-6	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
MW-3	MY	S	2002-2007	8	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
P-9	MY	D	NS	0	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
MW-5	MY	S	1995-2007	12	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
P-10	MY	D	NS	0	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
MW-0060	MY	S	2006-2007	3	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
MW-200	MY	D	2004-2007	11	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
RW-42	MY	S	2002-2007 ³	4	NE	NE	NE	NE	ND-270	NE	NE	ND-21	NE	NE	NE	NE	NE	NE	NE	NE	NE
MW-239	MY	D	2006-2007	2	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
RW-02	NF2 LNAPL	S	2003-2007	7	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
MW-240	NF2 LNAPL	D	2006-2007	2	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
MW-197	SWMU 1	S	2004-2007	11	NE	NE	NE	ND-85J	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
MW-198	SWMU 1	D	2004-2007	10	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE

Table 38. Deep Well Pairs – SVOC Exceedances

Well ID	Unit	Type	Years Sampled	# of Rnds.	Parameters/SRFI Evaluation Criteria ¹																
					Benzo(a)anthracene 0.1 µg/L	Benzo(a)pyrene 0.1 µg/L	Benzo(b)fluoranthene 0.2 µg/L	Bis(2-ethylhexyl)phthalate 3 µg/L	Caprolactam 100 µg/L	Chrysene 5 µg/L	Dibenzo(a,h)anthracene 0.3 µg/L	2,4-Dichlorophenol 20 µg/L	2,4-Dimethylphenol 100 µg/L	Indeno(1,2,3-cd)pyrene 0.2 µg/L	2-Methylnaphthalene 100 µg/L	Naphthalene 300 µg/L	o-Cresol 100 µg/L	p-Cresol 100 µg/L	PCP 0.3 µg/L	Phenanthrene 100 µg/L	Phenol 2000 µg/L
MW-195	SWMU 1	S	2004-2007	11	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
MW-196	SWMU 1	D	2004-2007	11	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
MW-205	SWMU 2	S	2004-2007	11	ND-3J	ND-3J	ND-2J	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
MW-206	SWMU 2	D	2004-2007	11	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
MW-243	SWMU 16	S	2006-2007	2	ND-2J	NE	NE	NE	NE	NE	NE	NE	170-220	NE	110-260	NE	78-110	NE	NE	NE	NE
MW-244	SWMU 16	D	2006-2007	2	NE	NE	NE	ND-4J	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
MW-117	SWMU 18	S	2002-2007	10	NE	NE	NE	NE	NE	NE	NE	NE	2700-55000	NE	23-130	NE	550-77000	640-87000	NE	NE	110-18000
MW-238	SWMU 18	D	2006-2007	2	NE	NE	NE	ND-8	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
NF-10	SWMU 20	S	2002-2007	18	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
MW-187	SWMU 20	D	2004	1	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
MW-114	SWMU 28	S	2002-2007	10	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
MW-115	SWMU 28	D	2002-2003	3	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
MW-136	SWMU 41	S	2002-2007	8	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
MW-237	SWMU 41	D	2006-2007	3	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE

Table 38. Deep Well Pairs – SVOC Exceedances

Well ID	Unit	Type	Years Sampled	# of Rnds.	Parameters/SRFI Evaluation Criteria ¹																
					Benzo(a)anthracene 0.1 µg/L	Benzo(a)pyrene 0.1 µg/L	Benzo(b)fluoranthene 0.2 µg/L	Bis(2-ethylhexyl)phthalate 3 µg/L	Caprolactam 100 µg/L	Chrysene 5 µg/L	Dibenzo(a,h)anthracene 0.3 µg/L	2,4-Dichlorophenol 20 µg/L	2,4-Dimethylphenol 100 µg/L	Indeno(1,2,3-cd)pyrene 0.2 µg/L	2-Methylnaphthalene 100 µg/L	Naphthalene 300 µg/L	o-Cresol 100 µg/L	p-Cresol 100 µg/L	PCP 0.3 µg/L	Phenanthrene 100 µg/L	Phenol 2000 µg/L
East Yard																					
MW-149	EY	S	2002-2007	9	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
MW-255	EY	D	2007	1	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
MW-6	EY	S	2002-2007	9	NE	NE	NE	ND-9J	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
P-7	EY	D	NS	0	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
MW-90	AOC 31	S	2003-2007	10	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	65-120	NE	NE	NE
MW-250	AOC 31	D	2007	2	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
MW-132	SWMU 8	S	2002-2007	8	ND-34J	ND-37J	ND-15J	12-300	NE	ND-49J	ND-1J	NE	110-1100	ND-1J	92-1800	220-1500	NE	NE	NE	1J-110	NE
MW-252	SWMU 8	D	2007	1	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
MW-141	SWMU 9	S	2002-2007	9	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
MW-178	SWMU 9	D	2003	2	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
MW-131	SWMU 10	S	2002-2007	14	NE	NE	NE	ND-6J	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	ND-14	NE
MW-246	SWMU 10	D	2007	1	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
SB-15	SWMU 25	S	2002-2007	15	NE	NE	NE	ND-8J	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
SB-10	SWMU 25	D	2004	1	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
MW-228	SWMU 42	S	2005-2007	2	NS	NS	NS	NS	NE	NE	NE	NE	NS	NE	NS	NE	NS	NS	NS	NE	NS

Table 38. Deep Well Pairs – SVOC Exceedances

Well ID	Unit	Type	Years Sampled	# of Rnds.	Parameters/SRFI Evaluation Criteria ¹																
					Benzo(a)anthracene 0.1 µg/L	Benzo(a)pyrene 0.1 µg/L	Benzo(b)fluoranthene 0.2 µg/L	Bis(2-ethylhexyl)phthalate 3 µg/L	Caprolactam 100 µg/L	Chrysene 5 µg/L	Dibenzo(a,h)anthracene 0.3 µg/L	2,4-Dichlorophenol 20 µg/L	2,4-Dimethylphenol 100 µg/L	Indeno(1,2,3-cd)pyrene 0.2 µg/L	2-Methylnaphthalene 100 µg/L	Naphthalene 300 µg/L	o-Cresol 100 µg/L	p-Cresol 100 µg/L	PCP 0.3 µg/L	Phenanthrene 100 µg/L	Phenol 2000 µg/L
MW-247	SWMU 42	D	2007	1	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Central Yard																					
MW-186	AOC 36	S	2004-2006	10	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
MW-185	AOC 36	D	2005-2006	6	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
MW-101	SWMU 34	S	2002-2006	11	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
MW-184	SWMU 34	D	2005-2006	6	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE

¹Detection range provided only where exceedances were found. Otherwise, "NE" is designated.²No shallow well pair in this area.³No sample collected in 2006.

Values in bold indicate one or more deep well exceedances.

S = Shallow Well

D = Deep Well

NE = No Exceedances

ND = Non-Detect

NS = Not Sampled

N/A = Not Applicable

Table 39. Deep Well Pairs – Ammonia and Metals

Well ID	Unit	Type	Years Sampled	# of Rnds.	Parameters/SRFI Evaluation Criteria ¹													
					NH ₃ 3000 µg/L	Sb 6 µg/L	As 3 µg/L	Ba 2000 µg/L	Be 1 µg/L	Cd 4 µg/L	Cr 70 µg/L	Co 5 µg/L	Pb 5 µg/L	Ni 100 µg/L	Se 40 µg/L	Ag 40 µg/L	Na 50000 µg/L	Th 2 µg/L
Main Yard																		
None ²	MY	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
MW-202	MY	D	2004-2007	11	NS	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	ND-295	6090000-7540000	NE
None ²	MY	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
MW-204	MY	D	2004-2007	11	NS	NE	ND-5.1J	NE	NE	NE	ND-930	5-17.3	NE	7.7J-1100	NE	ND-171	144000-5680000	NE
MW-3	MY	S	2002-2007	8	3800-7400	NE	ND-7.7J	NE	NE	NE	NE	51-67.2	NE	NE	NE	NE	833000-890000	ND-26.7
P-9	MY	D	NS	0	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
MW-5	MY	S	1995-2007	12	NE	NE	NE	NE	ND-2J	NE	NE	ND-6.1J	NE	NE	NE	NE	NE	NE
P-10	MY	D	NS	0	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
MW-0060	MY	S	2006-2007	3	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
MW-200	MY	D	2004-2007	11	NS	NE	9.5J-10.5J	NE	NE	NE	NE	3.9J-9.9	NE	9.3J-907	NE	NE	6820000-8900000	NE
RW-42	MY	S	2002-2007	4	NE	NS	ND-19.6J	NS	NS	NS	NS	NS	ND-68.5	NS	NS	NS	NS	NS
MW-239	MY	D	2006-2007	2	NS	NE	12.4J	NE	NE	NE	NE	NE	NE	NE	NE	NE	1810000	NE
RW-02	NF2 LNAPL	S	2003-2007	7	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	141000	NE
MW-240	NF2 LNAPL	D	2006-2007	2	NS	NE	ND-11.7J	NE	NE	NE	NE	NE	NE	NE	NE	NE	79700-81300	NE
MW-195	SWMU 1	S	2004-2007	11	NS	NE	NE	NE	NE	NE	NE	41.2-96.4	NE	17.5-211	NE	NE	40400-54300	NE
MW-196	SWMU 1	D	2004-2007	11	NS	NE	ND-10.1J	NE	NE	NE	ND-273	NE	NE	NE	NE	ND-185	2200000-7170000	NE
MW-197	SWMU 1	S	2004-2007	11	NS	ND-36.1	ND-35.4	NE	3.6J-18.2	ND-72.5	6.1J-1,860	946-1020	ND-36.5	163-4580	ND-71.1	NE	119000-994000	29.5-84J
MW-198	SWMU 1	D	2004-2007	10	NS	NE	ND-8J	NE	NE	NE	ND-182	NE	NE	ND-197	NE	NE	344000-8930000	NE
MW-205	SWMU 2	S	2004-2007	11	NS	NE	ND-16	NE	NE	NE	NE	NE	NE	NE	NE	NE	378000-532000	NE

Table 39. Deep Well Pairs – Ammonia and Metals

Well ID	Unit	Type	Years Sampled	# of Rnds.	Parameters/SRFI Evaluation Criteria ¹														
					NH ₃ 3000 µg/L	Sb 6 µg/L	As 3 µg/L	Ba 2000 µg/L	Be 1 µg/L	Cd 4 µg/L	Cr 70 µg/L	Co 5 µg/L	Pb 5 µg/L	Ni 100 µg/L	Se 40 µg/L	Ag 40 µg/L	Na 50000 µg/L	Th 2 µg/L	
MW-206	SWMU 2	D	2004-2007	11	NS	NE	ND-14.8J	NE	NE	ND-5.2	ND-235	3.8J-5.6	NE	19.2-270	NE	NE	3020000-7500000	NE	
MW-243	SWMU 16	S	2006-2007	2	NS	NE	20.1-27.8	NE	NE	NE	NE	3J-6.6	ND-7.3J	NE	NE	NE	326000-357000	NE	
MW-244	SWMU 16	D	2006-2007	2	NS	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	97300-104000	NE	
MW-117	SWMU 18	S	2002-2007	10	210J-30700	NE	ND-21.3	NE	NE	NE	NE	NE	ND-73	NE	NE	NE	1890000-3250000	NE	
MW-238	SWMU 18	D	2006-2007	2	NS	NE	ND-10.6J	NE	NE	NE	NE	NE	NE	NE	NE	NE	211000-256000	NE	
NF-10	SWMU 20	S	2002-2007	18	750-5500	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	100000-171000	NE	
MW-187	SWMU 20	D	2004	1	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	641000	NE	
MW-114	SWMU 28	S	2002-2007	10	NE	NE	ND-7J	NE	NE	NE	NE	NE	NE	NE	NE	NE	62000-69300	NE	
MW-115	SWMU 28	D	2002-2003	3	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	66500-76800	NE	
MW-136	SWMU 41	S	2002-2007	8	3500-13300	NE	ND-22.4	NE	NE	NE	NE	NE	NE	NE	NE	NE	1080000-1610000	NE	
MW-237	SWMU 41	D	2006-2007	3	20400-34500	NE	ND-40.4	NE	NE	NE	NE	ND-5.4	NE	NE	NE	NE	7990000-8790000	NE	
East Yard																			
MW-149	EY	S	2002-2007	9	7800-20300	NE	28.1-41.1	NE	NE	NE	NE	NE	NE	NE	NE	NE	1070000-1370000	NE	
MW-255	EY	D	2007	1	NS	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	4810000	NE	
MW-6	EY	S	2002-2007	9	NE	NE	NE	NE	2.1J-2.7J	2.2J-5.4	NE	108-143	ND-17.1J	141-171	NE	NE	71400-162000	NE	
P-7	EY	D	NS	0	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	
MW-90	AOC 31	S	2003-2007	10	2000-6000	NE	17-23.4	NE	NE	NE	NE	ND-6.3	ND-11.1J	NE	NE	NE	91700-117000	ND-15.2J	
MW-250	AOC 31	D	2007	2	NS	NE	13.6J-15.4J	NE	NE	NE	NE	NE	NE	NE	NE	NE	233000-239000	NE	
MW-132	SWMU 8	S	2002-2007	8	NE	NE	ND-69.6	NE	NE	NE	NE	NE	ND-470	NE	NE	NE	241000-830000	ND-14.2	
MW-252	SWMU 8	D	2007	1	NS	NE	61.5	NE	NE	NE	NE	NE	NE	NE	NE	NE	6530000	NE	

Table 39. Deep Well Pairs – Ammonia and Metals

Well ID	Unit	Type	Years Sampled	# of Rnds.	Parameters/SRFI Evaluation Criteria ¹													
					NH ₃ 3000 µg/L	Sb 6 µg/L	As 3 µg/L	Ba 2000 µg/L	Be 1 µg/L	Cd 4 µg/L	Cr 70 µg/L	Co 5 µg/L	Pb 5 µg/L	Ni 100 µg/L	Se 40 µg/L	Ag 40 µg/L	Na 50000 µg/L	Th 2 µg/L
MW-141	SWMU 9	S	2002-2007	9	NE	9.1J-13.2J	ND-22.6	NE	NE	NE	NE	NE	NE	NE	NE	NE	34300-55000	NE
MW-178	SWMU 9	D	2003	2	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
MW-131	SWMU 10	S	2002-2007	14	620J-4300	NE	ND-20.7	NE	NE	NE	NE	NE	ND-15.5J	NE	NE	NE	166000-249000	NE
MW-246	SWMU 10	D	2007	1	NS	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	95600	NE
SB-15	SWMU 25	S	2002-2007	15	ND-15200	NE	ND-7.7J	970-3080	NE	NE	NE	NE	ND-10.8J	NE	NE	NE	592000-4160000	ND-18.5J
SB-10	SWMU 25	D	2004	1	20000	NS	NS	NS	NS	NE	NE	NS	NE	NE	NS	NE	NS	NS
MW-228	SWMU 42	S	2005-2007	2	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
MW-247	SWMU 42	D	2007	1	NS	NE	13.9J	NE	NE	NE	NE	NE	NE	NE	NE	NE	173000	NE
Central Yard																		
MW-186	AOC 36	S	2004-2006	10	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	7900-15000	NE
MW-185	AOC 36	D	2005-2006	6	NE	NE	ND-26.1	NE	ND-1.3J	NE	NE	ND-11.1	ND-44.7	NE	NE	NE	29000-162000	NE
MW-101	SWMU 34	S	2002-2006	11	11200-14400	NE	ND-28.8	NE	NE	NE	NE	8.3-196	ND-49.9	NE	NE	NE	223000-294000	NE
MW-184	SWMU 34	D	2005-2006	6	7000	NE	ND-8.8J	NE	NE	NE	NE	82.9-144	ND-67.7	NE	NE	NE	302000-383000	ND-15.5J

¹Detection range provided only where exceedances were found. Otherwise, "NE" is designated.²No shallow well pair in this area.³No sample collected in 2006.

Values in bold indicate one or more deep well exceedances.

S = Shallow Well

D = Deep Well

NE = No Exceedances

ND = Non-Detect

NS = Not Sampled

N/A = Not Applicable

Deep monitoring wells MW-196 and MW-198 were paired with shallow wells MW-195 and MW-197, respectively, to investigate the hydrogeologic relationship between the first shallow and first native water-bearing zones across SWMU 1. SWMU 1 is located in the most northern portion of the NF along the Woodbridge Creek. Figure 34 indicates that groundwater flow in the first native water-bearing zone across SWMU 1 is generally northeast, towards the Woodbridge Creek with a lateral hydraulic gradient of 0.007407.

Well Pair MW-195 and MW-196

Deep monitoring well MW-196 was paired with shallow well MW-195 to investigate the hydrogeologic relationship between the first shallow and first native water-bearing zones across the northern border of SWMU 1. For this well pair, a downward vertical gradient of 0.1705 was calculated from deep well MW-196 to shallow well MW-195. Based upon the boring logs from these well installations, an organic clay/peat layer (Clay Horizon A) is evident at approximately 12.0 to 18.0 ft. bgs beneath the fill layer. Carbon steel casing was installed at a depth of 15.5 ft. bgs to hydraulically isolate the upper fill layer and the first native water-bearing zone beneath at deep well MW-196.

As presented in Table 37 through Table 39, groundwater samples have been collected from wells MW-195 and MW-196 since 2004. These wells have been analyzed for VOCs, SVOCs, metals, chlorides, and total dissolved solids.

Since 2004, shallow well MW-195 has not exhibited any exceedances of the SRFI Evaluation Criteria for VOCs or SVOCs. However, MW-195 has exhibited exceedances of the SRFI Evaluation Criteria for cobalt, nickel, and sodium.

Since 2004, deep well MW-196 has exhibited only one exceedance of the SRFI Evaluation Criteria for VOCs, specifically benzene (1 µg/L). Benzene was only detected in one of eleven rounds of quarterly sampling since 2004. This occurrence was in October 2005 and the value was 16 µg/L. Benzene has not been detected at well MW-196 in the last six quarterly rounds of sampling as of April 2007. No SVOCs were detected in concentrations exceeding the SRFI Evaluation Criteria in groundwater samples from MW-196. In contrast to the metals found in shallow well MW-195, deep well MW-196 has exhibited concentrations of arsenic, chromium, and silver exceeding the SRFI Evaluation Criteria. Exceedances of sodium criteria have been evident in both wells.

Well Pair MW-197 and MW-198

Deep monitoring well MW-198 was paired with shallow well MW-197 to investigate the hydrogeologic relationship between the first shallow and first native water-bearing zones along the eastern border of SWMU 1. For this well pair, a downward vertical gradient of 0.1173 was calculated from deep well MW-198 to shallow well MW-197. Based upon the boring logs from these well installations, an organic clay/peat layer (Clay Horizon A) is evident at approximately 9.0 to 12.0 ft. bgs beneath the fill layer. Carbon steel casing

was installed at a depth of 14.0 ft. bgs to hydraulically isolate the upper fill layer and the first native water-bearing zone beneath at deep well MW-198.

As presented in Table 37 through Table 39, groundwater samples have been collected from wells MW-197 and MW-198 since 2004. These wells have been analyzed for VOCs, SVOCs, metals, chlorides, and total dissolved solids.

Since 2004, shallow well MW-197 has not exhibited any exceedances of the SRFI Evaluation Criteria for VOCs. One exceedance of the SRFI Evaluation Criteria for the SVOC bis(2-ethylhexyl)phthalate (DEHP) (3 µg/L) was detected in one of the six rounds of sampling analyzed for SVOCs since 2004. This occurrence was in April 2005 and the value was 85 µg/L. DEHP has not been detected at well MW-197 in the two subsequent rounds of sampling in 2006. However, DEHP was detected at well MW-197 in April 2007 (3J µg/L). MW-197 has exhibited exceedances of the SRFI Evaluation Criteria for antimony, arsenic, beryllium, cadmium, chromium, cobalt, lead, nickel, selenium, sodium, and thallium.

Since 2004, deep well MW-198 has not exhibited any exceedance of the SRFI Evaluation Criteria for VOCs or SVOCs. However, MW-198 has exhibited exceedances of the SRFI Evaluation Criteria for arsenic, chromium, nickel, and sodium.

SWMU 2 – Surge Pond

Four deep permanent groundwater monitoring wells (MW-200, MW-202, MW-204, and MW-206) were installed around SWMU 2 in 2004 after the RFI as part of the Surge Pond Closure Project. They were both screened in the first native water-bearing zone beneath the fill and Clay Horizon A (see Table 35).

Monitoring wells MW-200 and MW-206 were paired with shallow wells MW-0060 and MW-205 respectively, to investigate the hydrogeologic relationship between the first shallow and first native water-bearing zones across SWMU 2. SWMU 2 is located in the northern portion of the NF along the Woodbridge Creek and is surrounded by a horseshoe shape bentonite slurry wall and sheet piling (see Figure 34). Figure 34 indicates that groundwater flow in the first native water-bearing zone across SWMU 2 is generally northeast, towards the Woodbridge Creek with a lateral hydraulic gradient of 0.003448 on the southern side of the unit.

Well Pair MW-0060 and MW-200

Deep monitoring well MW-200 was paired with shallow well MW-0060 to investigate the hydrogeologic relationship between the first shallow and first native water-bearing zones in the northwestern corner of SWMU 2. For this well pair, a downward vertical gradient of 0.1620 was calculated from deep well MW-200 to shallow well MW-0060. Based upon the boring logs from these well installations, an organic clay/peat layer (Clay Horizon A) is evident at approximately 14.0 to 22.5 ft. bgs beneath the fill layer. Carbon

steel casing was installed at a depth of 18.0 ft. bgs to hydraulically isolate the upper fill layer and the first native water-bearing zone beneath at deep well MW-200.

As presented in Table 37 through Table 39, groundwater samples have been collected from wells MW-0060 since 2006 and MW-200 since 2004. Well MW-0060 has been analyzed for VOCs, total iron, dissolved iron, ammonia, nitrate nitrogen, nitrite nitrogen, sulfate, sulfide, chlorides, and total dissolved solids. MW-200 has been analyzed for VOCs, SVOCs, metals, chlorides, and total dissolved solids.

Since 2006, shallow well MW-0060 has exhibited exceedances of the SRFI Evaluation Criteria for VOCs, specifically benzene (1 µg/L). Benzene was detected in all three semi-annual rounds of sampling in 2006 to June 2007 ranging from 48 to 69 µg/L. SVOCs and metals (except total iron) have not been analyzed at MW-0060.

Since 2004, deep well MW-200 has exhibited no exceedances of the SRFI Evaluation Criteria for VOCs or SVOCs. However, deep well MW-200 has exhibited concentrations of arsenic, cobalt, nickel, and sodium exceeding the SRFI Evaluation Criteria.

MW-202

Deep monitoring well MW-202 is located on the northern side of SWMU 2 and is not paired with a shallow well. Based upon the boring logs from these well installations, an organic clay/peat layer (Clay Horizon A) is evident at approximately 16.5 to 26.0 ft. bgs beneath the fill layer. Carbon steel casing was installed at a depth of 21.0 ft. bgs to hydraulically isolate the upper fill layer and the first native water-bearing zone beneath at deep well MW-202.

As presented in Table 37 through Table 39, groundwater samples have been collected from well MW-202 since 2004. Well MW-202 has been analyzed for VOCs, SVOCs, chlorides, and TDS.

Since 2004, deep well MW-202 has exhibited no exceedances of the SRFI Evaluation Criteria for VOCs. The only SVOC criteria exceeded was for DEHP (3 µg/L). DEHP was only detected in one of the six rounds of sampling analyzed for SVOCs since 2004. This occurrence was in October 2006 and the value was 4J µg/L. DEHP has not been detected at well MW-202 in the one subsequent round of SVOC sampling in May 2007. However, deep well MW-202 has exhibited concentrations of silver and sodium exceeding the SRFI Evaluation Criteria.

MW-204

Deep monitoring well MW-204 is located in the northeastern corner of SWMU 2 and is not paired with a shallow well. Based upon the boring logs from these well installations, an organic clay/peat layer (Clay Horizon A) is evident at approximately 13.0 to 22.0 ft. bgs beneath the fill layer. Carbon steel casing was installed at a depth of 17.0 ft. bgs to

hydraulically isolate the upper fill layer and the first native water-bearing zone beneath at deep well MW-204.

As presented in Table 37 through Table 39, groundwater samples have been collected from well MW-204 since 2004. Well MW-204 has been analyzed for VOCs, SVOCs, chlorides, and TDS.

Since 2004, deep well MW-204 has exhibited exceedances of the SRFI Evaluation Criteria for VOCs, specifically bromodichloromethane (1 µg/L) and dibromodichloromethane (1 µg/L). Bromodichloromethane was detected in the first three of seven rounds of sampling (ranging from 2J µg/L to 7 µg/L) in 2004 to 2005. Dibromodichloromethane was detected in only one of seven rounds of sampling (3J µg/L). This occurrence was in April 2005 (3J µg/L). Subsequent samples collected from October 2005 to May 2007 have been non-detect for bromodichloromethane and dibromodichloromethane.

The only exceedance of the SRFI Evaluation Criteria for SVOCs was DEHP (3 µg/L). DEHP was detected in two of the seven rounds of sampling analyzed for SVOCs since 2004. These occurrences were in December 2004 (5J µg/L) and April 2006 (6 µg/L). DEHP has not been detected at well MW-204 in the two subsequent rounds of SVOC sampling in October 2006 and May 2007. In addition, deep well MW-204 has exhibited concentrations of arsenic, chromium, cobalt, nickel, silver, and sodium exceeding the SRFI Evaluation Criteria.

Well Pair MW-205 and MW-206

Deep monitoring well MW-206 was paired with shallow well MW-205 to investigate the hydrogeologic relationship between the first shallow and first native water-bearing zones in the northwestern corner of SWMU 2. For this well pair, a downward vertical gradient of 0.1275 was calculated from deep well MW-206 to shallow well MW-205. Based upon the boring logs from these well installations, an organic clay/peat layer (Clay Horizon A) is evident at approximately 12.0 to 22.0 ft. bgs beneath the fill layer. Carbon steel casing was installed at a depth of 16.0 ft. bgs to hydraulically isolate the upper fill layer and the first native water-bearing zone beneath at deep well MW-206.

As presented in Table 37 through Table 39, groundwater samples have been collected from wells MW-205 and MW-206 since 2004. Wells MW-205 and MW-206 have been analyzed for VOCs, SVOCs, metals, chlorides, and TDS.

Between 2004 and April 2007, shallow well MW-205 has exhibited exceedances of the SRFI Evaluation Criteria for VOCs, specifically benzene (1 µg/L) for all eleven sampling rounds. During that time, benzene exceedances ranged from 7 to 70 µg/L. Exceedances of the SRFI Evaluation Criteria for SVOCs included benzo(a)anthracene (0.1 µg/L), benzo(a)pyrene (0.1 µg/L), and benzo(b)fluoranthene (0.2 µg/L). These three SVOC compounds have only been detected in two of the seven rounds of sampling analyzed for SVOCs since 2004. The last occurrence was in October 2006. SVOCs were not detected

at well MW-205 during the last sampling round in April 2007. In addition, shallow well MW-205 has exhibited concentrations of arsenic and sodium exceeding the SRFI Evaluation Criteria.

In contrast, deep well MW-206 has exhibited no exceedances of the SRFI Evaluation Criteria for VOCs and SVOCs since 2004. However, deep well MW-200 has exhibited concentrations of arsenic, cadmium, chromium, cobalt, nickel, and sodium exceeding the SRFI Evaluation Criteria.

NF 2

One existing deep permanent groundwater monitoring well (MW-115) was installed during the RFI in 2002 at NF2. One deep permanent groundwater monitoring well (MW-240) was installed in the NF2 Area during the SRFI. Both are screened in the lower water-bearing zone beneath the fill and Clay Horizon A (see Table 34 and Table 35 for respective well construction information).

Figure 34 indicates that groundwater flow across the NF2 Area is generally northeast, towards the Woodbridge Creek. Deep groundwater flow across the area occurs within the first water-bearing zone of the native material, and flows under an average gradient of 0.00817.

Well Pair MW-114 and MW-115

Deep monitoring well MW-115 was paired with a previously installed shallow well (MW-114) to investigate the hydrogeologic relationship between the first shallow and first native water-bearing zones across the NF2 Area. An upward vertical gradient of 0.1263 was calculated from deep well MW-115 to shallow well MW-114. Based on the boring logs from these two wells, no organic clay/peat horizon is evident at this location of the site.

Following groundwater gauging of MW-114 and MW-115, groundwater samples were collected and analyzed for VOCs, SVOCs, metals, alkalinity, ammonia nitrogen, carbonate, bicarbonate, chloride, nitrate nitrogen, nitrite nitrogen, sulfate, TDS, and hardness.

Between 2002 and June 2007, shallow well MW-114 did not exhibit an exceedance of the SRFI Evaluation Criteria for VOCs and SVOCs for all ten sampling rounds. In addition, shallow well MW-114 has only exhibited concentrations of arsenic and sodium exceeding the SRFI Evaluation Criteria.

Between October 2002 and September 2003, deep well MW-115 exhibited no exceedances of the SRFI Evaluation Criteria for VOCs and SVOCs with the exception of the VOC bromodichloromethane. In October 2002, deep well MW-115 exhibited one exceedance (6 µg/L) of the SRFI Evaluation Criteria for bromodichloromethane (1 µg/L). Bromodichloromethane was detected in only the first of three rounds of sampling.

Subsequent samples collected in February and September 2003 were non-detect for bromodichloromethane. Finally, deep well MW-115 has exhibited concentrations of sodium exceeding the SRFI Evaluation Criteria.

Well Pair RW-02 and MW-240

Deep monitoring well MW-240 was paired with a previously installed shallow well (RW-02) to investigate the hydrogeologic relationship between the first shallow and first native water-bearing zones across the NF2 Area. For the well pair RW-02 and MW-240, an upward vertical gradient of 0.1409 was calculated from deep well MW-240 to shallow well RW-02. Based upon the boring logs from the RW-02 and MW-240 installations, both wells intersect an organic clay/peat horizon at approximately 12.0 ft. bgs. Based upon the evidence of an upward vertical gradient between these wells, and the slightly artesian condition found within deep well MW-240, the organic clay/peat horizon appears to be hydraulically isolating the first shallow water-bearing zone from the first native water-bearing zone in this location.

Following groundwater gauging of MW-240 and RW-02, groundwater samples were collected and analyzed for VOCs, SVOCs, and metals. Dissolved concentrations of benzene (190 µg/L), cyclohexane (120 µg/L), and methylcyclohexane (150 µg/L) were detected in groundwater from RW-02 in concentrations exceeding the SRFI Evaluation Criteria (1 µg/L, 100 µg/L, and 100 µg/L, respectively). However, no VOCs were detected in MW-240, which provides further evidence of hydraulic isolation between the first shallow water-bearing zone and first native water-bearing zone in this location. No SVOCs were detected in concentrations exceeding the SRFI Evaluation Criteria in groundwater samples from MW-240 and RW-02.

Wells RW-02 and MW-240 contained concentrations of total iron exceeding the SRFI Evaluation Criteria. Additionally, RW-02 contained dissolved concentrations of iron, arsenic, manganese, and sodium above the SRFI Evaluation Criteria.

NF3B

One existing deep permanent groundwater monitoring well (MW-187) was installed after the RFI in 2004 at NF3B. It was screened in the lower water-bearing zone beneath the fill and Clay Horizon A (see Table 35 for well construction information). Well MW-187 replaced well MW-180, which was abandoned.

Figure 34 indicates that groundwater flow across the NF3B Area is generally east-northeast, towards the Woodbridge Creek. Deep groundwater flow across the area occurs within the first water-bearing zone of the native material, and flows under an average gradient of 0.0020833.

Well Pair NF-10 and MW-187

Deep monitoring well MW-187 was paired with a previously installed shallow well (NF-10) to investigate the hydrogeologic relationship between the first shallow and first native water-bearing zones across the NF3B Area. For the well pair NF-10 and MW-187, a downward vertical gradient of 0.03594 was calculated from deep well MW-187 to shallow well NF-10. Based on the boring logs from these two wells, no organic clay/peat horizon is evident at this location of the site.

Groundwater samples were collected from wells NF-10 and MW-187 and analyzed for VOCs, SVOCs, metals, alkalinity, ammonia nitrogen, chloride, nitrate nitrogen, nitrite nitrogen, sulfate (NF-10 only), sulfide (NF-10 only), and TDS.

As shown in Table 37, between 2002 to June 2007 (18 sampling rounds), shallow well NF-10 has exhibited exceedances of the SRFI Evaluation Criteria for five VOCs (benzene, cyclohexane, methylcyclohexane, 1,1,2-trichloroethane, and xylene). The benzene criterion has been exceeded in each sampling round with values ranging from 48 to 790 µg/L. The cyclohexane criterion has been exceeded in all seven rounds where it was sampled, with values ranging from 240 to 340 µg/L. The methylcyclohexane criterion has been exceeded in all seven rounds where it was sampled, with values ranging from 140 to 240 µg/L. The 1,1,2-trichloroethane criterion was exceeded only once in seven sampling rounds, and the other rounds were all non-detect. The 1,1,2-trichloroethane concentration on March 2004 was 71 µg/L. The xylene criterion was exceeded in fourteen of eighteen sampling rounds with values ranging from 230 to 1,800 µg/L. No SVOC exceedances are evident at well NF-10. In addition, shallow well NF-10 has only exhibited concentrations of sodium exceeding the SRFI Evaluation Criteria.

In contrast, deep well MW-187 has only been sampled once in May 2004. No VOCs and SVOCs were evident above the SRFI Evaluation Criteria. The only exceedance was for sodium.

NF 5

Two permanent deep groundwater monitoring wells (MW-237 and MW-238) were installed in NF5 during the SRFI. Both deep permanent monitoring wells were screened in the lower water-bearing zone beneath the fill and Clay Horizon A (see Table 34). The February 2007 deep groundwater contour map, however, depicts groundwater flowing in a more north-northeasterly direction across NF5 (Figure 34). Deep groundwater flow across the area occurs within the first water-bearing zone of the native material, and flows under an average gradient of 0.0063478 between deep wells MW-237 and MW-238 towards the Woodbridge Creek.

Well Pair MW-136 and MW-237

Monitoring well MW-237 was paired with a previously installed shallow well (MW-136) to investigate the hydrogeologic relationship between the first shallow and first native water-bearing zones across the NF3A Area.

For the well pair MW-136 and MW-237, a downward vertical gradient of 0.07548 was calculated from shallow well MW-136 to deep well MW-237. Based upon the boring logs from the MW-136 and MW-237 installations, both MW-136 and MW-237 intersect Clay Horizon A between 4.0 and 6.0 ft. bgs. In addition, the descriptions of the sediments above and below Clay Horizon A are similar between these two wells. Despite the continuity in Clay Horizon A between these wells, the evidence of a downward vertical gradient between the wells suggests there is a potential hydraulic interconnectivity between the first shallow water-bearing zone and first native water-bearing zone at this location.

Following groundwater gauging of MW-136 and MW-237, groundwater samples were collected and analyzed for VOCs, SVOCs, and metals on May 24 and May 10, 2007, respectively. Although there is evidence of hydraulic interconnectivity between water-bearing zones from MW-136 and MW-237, no dissolved VOCs or SVOCs were detected in groundwater samples from both wells in concentrations exceeding the SRFI Evaluation Criteria.

In addition, groundwater samples collected from MW-136 and MW-237 have contained concentrations of sodium in excess of the SRFI Evaluation Criteria.

Well Pair MW-177 and MW-238

As part of the SRFI, deep monitoring well MW-238 was paired with shallow well MW-177, a previously installed shallow well, to investigate the hydrogeologic relationship between the first shallow and first native water-bearing zones across the NF5 Area.

For the well pair MW-117 and MW-238, an upward vertical gradient of 0.1112 was calculated from deep well MW-238 to shallow well MW-117. Based upon the boring logs from the MW-117 and MW-238 installations, both wells intersect Clay Horizon A at approximately 6.0 ft. bgs. Based on the evidence of an upward vertical gradient between these wells and the artesian condition found within deep well MW-238, Clay Horizon A appears to be hydraulically isolating the first shallow water-bearing zone from the first native water-bearing zone in this location.

Following groundwater gauging of MW-117 and MW-238, groundwater samples were most recently collected and analyzed for VOCs, SVOCs, and metals on May 11, 2007 (MW-238) and June 6, 2007 (MW-117). Sample M117B1, collected from MW-117, was analyzed for BTEX. Benzene (840 µg/L) was detected above the SRFI Evaluation Criteria (1 µg/L). In addition, SVOCs including p-cresol (640 µg/L), o-cresol (550 µg/L), and 2,4-dimethylphenol (2,700 µg/L) were detected above the SRFI Evaluation

Criteria (100 µg/L, 100 µg/L, and 100 µg/L respectively). In contrast, no VOCs were detected in MW-238 in either of the most recent sampling events for this well (May 11 and December 15 2007). Only one SVOC compound, DEHP (8 µg/L), was detected above the SRFI Evaluation Criteria (3 µg/L), and has never been detected in MW-117. This analytical data provides further evidence of hydraulic isolation between the first shallow water-bearing zone and first native water-bearing zone in this location.

Historical groundwater data from MW-117 indicate metals exceeding the SRFI Evaluation Criteria, including arsenic, iron, lead, manganese, and sodium. The two most recent samples from MW-238 also contained concentrations of arsenic, iron, manganese, and sodium exceeding the SRFI Evaluation Criteria. In addition, MW-238 also contained a concentration of aluminum in excess of the SRFI Evaluation Criteria.

NF 6

Two deep monitoring wells (MW-239 and MW-244) were installed within NF6 during the SRFI. Monitoring well MW-239 was paired with previously installed shallow monitoring well RW-42, and MW-244 was paired with shallow monitoring well MW-243, to investigate the hydrogeologic relationship between the first shallow and first native water-bearing zones across the NF6 Area.

The deep groundwater contour map generated from the February 2007 site-wide gauging data (Figure 34), indicates that groundwater flow across the NF6 Area is generally north-northeast, towards the Woodbridge Creek. Deep groundwater flow across the area occurs within the first water-bearing zone of the native material, and flows under an average gradient of 0.000475.

Well Pair MW-239 and RW-42

A downward vertical gradient of 0.01063 was calculated from deep well MW-239 to shallow well RW-42. Based upon the boring logs from the RW-42 and MW-239 installations, Clay Horizon A was intersected in MW-239 at a depth of 16.8 ft. bgs, but was never encountered in RW-42, which was only advanced to 10.5 ft. bgs. Based on the evidence of an upward vertical gradient between these wells, and the artesian condition found within deep well MW-239, Clay Horizon A appears to be hydraulically isolating the first shallow water-bearing zone from the first native-water-bearing zone in this location.

Following groundwater gauging of RW-42 and MW-239, groundwater samples were collected and analyzed for VOCs, SVOCs, and metals on June 12 and May 15, 2007, respectively. Concentrations of the VOC benzene (3J µg/L) and the SVOC 2,4-dichlorophenol (21 µg/L) were detected in groundwater from RW-42 in excess of the SRFI Evaluation Criteria (1 µg/L and 20 µg/L, respectively). Only one VOC, bromodichloromethane (2J µg/L), was detected in groundwater from MW-239 at a concentration exceeding the SRFI Evaluation Criteria (1 µg/L). No SVOCs were detected in concentrations exceeding the SRFI Evaluation Criteria in MW-239. The

variation in VOC and SVOC detections between RW-42 and MW-239 provides further evidence of hydraulic isolation between the first shallow water-bearing zone and first native water-bearing zone in this location. The most recent sampling of MW-239 on May 15, 2007 revealed metals including aluminum, arsenic, total and dissolved iron, manganese, and sodium in concentrations exceeding the SRFI Evaluation Criteria.

Well Pair MW-243 and MW-244

An upward vertical gradient of 0.03414 was calculated from deep well MW-244 to shallow well MW-243. Based upon the boring logs from the MW-243 and MW-244 installations, Clay Horizon A was intersected at both boring locations. The bottom of the screen in monitoring well MW-243 was placed on top of Clay Horizon A, at a depth of 8.5 ft. bgs, and the top of screen in MW-244 was placed at 32.0 ft. bgs, beneath Clay Horizon A in a red brown till horizon. Based on the evidence of an upward vertical gradient between these wells, and the artesian condition found within deep well MW-244, Clay Horizon A appears to be hydraulically isolating the first shallow water-bearing zone from the first native water-bearing zone in this location.

The most recent groundwater gauging and sampling of MW-243 and MW-244 was conducted on May 10, 2007. As previously mentioned, concentrations of VOCs and SVOCs were detected in excess of the SRFI Evaluation Criteria in groundwater from MW-243. However, no VOCs or SVOCs were detected in concentrations exceeding the SRFI Evaluation Criteria in MW-244. This provides further evidence of hydraulic isolation between the first shallow water-bearing zone and first native water-bearing zone in this location. Both MW-243 and MW-244 contained metals including total iron, manganese, and sodium in concentrations exceeding the SRFI Evaluation Criteria. Only MW-243 contained exceedances of dissolved lead, arsenic, and cobalt. MW-244 also contained aluminum in excess of the SRFI Evaluation Criteria.

East Yard Area

AOI 1

Two deep monitoring wells (MW-246 and MW-247) were installed within AOI 1 during the SRFI. These wells were paired with previously installed shallow wells (MW-131 and MW-228, respectively) to investigate the hydrogeologic relationships between the first shallow and first native water-bearing zones across the AOI 1 Area.

The deep groundwater contour map generated from the February 2007 site-wide gauging data (Figure 34), indicates that groundwater flow is generally northeast, towards the Woodbridge Creek at AOI 1. Deep groundwater flow across AOI 1 occurs within the first water-bearing zone of the native material, and flows under an average gradient of 0.00675.

Well Pair MW-131 and MW-246

A downward vertical gradient of 0.08902 was calculated from shallow well MW-131 to deep well MW-246. Based upon the boring logs from the MW-131 and MW-246 installations, both wells intersect a peat horizon at approximately 12.0 ft. bgs. However, the descriptions of the sediments above and below this peat vary between these two wells. Based on this variance and the evidence of a downward vertical gradient between the wells, there is the potential for hydraulic interconnectivity between the first shallow water-bearing zone and first native water-bearing zone at this location.

Groundwater samples were collected from shallow well MW-131 and analyzed for VOCs, SVOCs, metals, alkalinity, ammonia nitrogen, bicarbonate, carbonate, chloride, nitrate nitrogen, nitrite nitrogen, sulfate, sulfide, TDS, and total hardness. Groundwater samples were collected from deep well MW-246 and analyzed for VOCs, SVOCs, and metals. Table 37 through Table 39 contains a summary of exceedances of the SRFI Evaluation Criteria for all shallow and deep well pairs.

As shown in Table 37, between 2002 and April 2007 (14 sampling rounds), shallow well MW-131 has only exhibited exceedances of the SRFI Evaluation Criteria for four VOCs (benzene, cyclohexane, 1,2-dichloroethane, and vinyl chloride (VC)). The benzene criterion was exceeded in each sampling round, with values ranging from 120 to 1,100 µg/L. The cyclohexane criterion was exceeded in three sampling rounds (2003 and 2005), with values ranging from 130 to 150 µg/L. In a subsequent round in April 2007, cyclohexane was detected but not an exceedance. The 1,2-dichloroethane criterion was exceeded in one sampling round with a value of 24 µg/L in August 2004. In all subsequent sampling rounds including April 2007, 1,2-dichloroethane was not detected. The vinyl chloride criterion was exceeded in five sampling rounds (2003 and 2005) with values ranging from 2 to 5 µg/L. All subsequent rounds were non-detect for vinyl chloride, including the April 2007 round.

The only exceedances of the SRFI Evaluation Criteria for SVOCs were DEHP (3 µg/L) and pentachlorophenol (PCP) (0.3 µg/L) at well MW-131. DEHP was only detected in one of the six rounds of sampling analyzed for SVOCs in 2002 and 2003. This occurrence was in April 2003 and the value was 6J µg/L. DEHP was not detected at well MW-131 in the two subsequent rounds of sampling in 2003. PCP was only detected in one of the six rounds of sampling analyzed for SVOCs in 2002 and 2003. This occurrence was in January 2003 and the value was 14 µg/L. PCP was not detected at well MW-131 in the three subsequent rounds of sampling in 2003. In addition, shallow well MW-131 has only exhibited concentrations of arsenic and lead exceeding the SRFI Evaluation Criteria.

Groundwater samples were collected from SRFI deep well MW-246 and analyzed for VOCs, SVOCs, and metals in February 2007. Despite evidence of hydraulic interconnectivity between water-bearing zones, MW-246 samples contained no dissolved VOCs or SVOCs in concentrations exceeding the SRFI Evaluation Criteria. Well MW-246 contained concentrations of sodium exceeding the SRFI Evaluation Criteria.

Well Pair MW-228 and MW-247

A downward vertical gradient of 0.1973 was calculated from shallow well MW-228 to deep well MW-247. Based upon the boring logs from the MW-228 and MW-247 installations, only MW-247 intersects the peat horizon, at approximately 10.0 ft. bgs. In addition, the descriptions of the sediments above and below the peat horizon vary between these two wells. Based on the discontinuity of the peat, the variance in sediments above and below the peat horizon, and the evidence of a downward vertical gradient between wells, a degree of hydraulic interconnectivity between the first shallow water-bearing zone and first native water-bearing zone in this location can be inferred.

Shallow well MW-228 is monitored for the presence of LNAPL. In February 2007, no LNAPL was detected and a groundwater sample was collected for BTEX analysis. The results indicated only one exceedance of the SRFI Evaluation Criteria for benzene (3J $\mu\text{g/L}$). However, other nearby wells in that area exhibit higher benzene concentrations (see Figure 37). For example, CMS shallow well MW-272 exhibited five exceedances of the SRFI Evaluation Criteria for VOCs (benzene, 1 $\mu\text{g/L}$; ethylbenzene, 700 $\mu\text{g/L}$; methyl ethyl ketone (MEK), 300 $\mu\text{g/L}$; toluene, 1,000 $\mu\text{g/L}$; and xylene, 1,000 $\mu\text{g/L}$) in February 2007. The concentrations were benzene, 9,500 $\mu\text{g/L}$; ethylbenzene, 870 $\mu\text{g/L}$; MEK, 880 $\mu\text{g/L}$; toluene, 10,000 $\mu\text{g/L}$; and xylene, 6,600 $\mu\text{g/L}$. During this sampling round, SVOCs were not analyzed at MW-272 and the only metal analyzed was iron, for which there was an exceedance.

A groundwater sample was collected from deep well MW-247 and analyzed for VOCs, SVOCs, and metals in February 2007. Despite evidence of hydraulic interconnectivity between water-bearing zones, deep well MW-247 samples contained no dissolved VOCs or SVOCs in concentrations exceeding the SRFI Evaluation Criteria. MW-247 contained concentrations of arsenic and sodium exceeding the SRFI Evaluation Criteria.

AOI 2

During the RFI, one deep well (MW-178) was installed in AOI 2 (Tank Basin 753). During the SRFI in 2006, another deep monitoring well (MW-255) was installed within AOI 2 near the central wharf area. These wells were paired with previously installed shallow wells (MW-141 and MW-149, respectively) to investigate the hydrogeologic relationships between the first shallow and first native water-bearing zones across the AOI 2 Area. Table 34 and Table 35 provide well construction information.

The deep groundwater contour map generated from the February 2007 site-wide gauging data (Figure 34), indicates that groundwater flow across AOI 2 is generally east-northeast, towards the Woodbridge Creek. Deep groundwater flow across the AOI 2 Area occurs within the first water-bearing zone of the native material, and flows under an average gradient of 0.00947.

Well Pair MW-141 and MW-178

Deep monitoring well MW-178 was paired with a previously installed shallow well (MW-141) to investigate the hydrogeologic relationship between the first shallow and first native water-bearing zones across AOI 2 Area. A downward vertical gradient of 0.03628 was calculated between deep well MW-178 to shallow well MW-141. Based on the boring logs from these two wells, no organic clay/peat horizon is evident at this location of the site. The fill/native contact was encountered at 15.0 ft. bgs. The native material is composed of light gray silts, clays, and fine sands. Carbon steel casing was installed at a depth of 15.0 ft. bgs to attempt to hydraulically isolate the upper fill layer and the first native water-bearing zone beneath at deep well MW-178.

Groundwater samples were collected from MW-141 and MW-178 and analyzed for VOCs, SVOCs, metals, alkalinity, ammonia nitrogen, bicarbonate, carbonate, chloride, nitrate nitrogen, nitrite nitrogen, sulfate, sulfide, TDS, and total hardness. Table 37 through Table 39 contain a summary of exceedances of the SRFI Evaluation Criteria for all shallow and deep well pairs.

As shown in Table 37, between 2002 and April 2007 (10 sampling rounds), shallow well MW-141 has only exhibited an exceedance of the SRFI Evaluation Criteria for one VOC (benzene). The benzene criterion was exceeded in the first three of ten sampling rounds with values ranging from 9 to 29 µg/L. Those exceedances for benzene occurred in 2002 and 2003. Benzene has not been detected at well MW-141 since 2003 including the last sampling round in April 2007. No SVOC exceedances are evident at well MW-141. In addition, shallow well MW-141 has exhibited concentrations of antimony, arsenic, and sodium exceeding the SRFI Evaluation Criteria.

In contrast, deep well MW-178 has only been sampled twice (May and October 2003). No VOCs, SVOCs, or metals concentrations (other than iron and manganese) were evident above the SRFI Evaluation Criteria.

Well Pair MW-149 and MW-255

A downward vertical gradient of 0.09290 was calculated from shallow well MW-149 to deep well MW-255. Based upon the boring logs from the MW-149 and MW-255 installations, both wells intersect an organic silt horizon with peat and root fragments between 12.0 and 14.0 ft. bgs. The description of the sediments below this interval in MW-255 indicates that organic and inorganic silty clay extends to the screen interval, where a medium to coarse sand was intersected. According to the boring log, the well was cased at 17.0 ft. bgs, five feet into the clay horizon. The boring log information suggests that a sufficient confining layer exists between the first shallow water-bearing zone and the first native water-bearing zone. However, the gauging data defines a downward vertical gradient between these wells, suggesting a degree of hydraulic interconnectivity between the two water-bearing zones.

Following groundwater gauging of MW-255, a groundwater sample was collected and analyzed for VOCs, SVOCs, and metals. Despite evidence of hydraulic interconnectivity between water-bearing zones in the MW-255 vicinity, the groundwater sample contained no dissolved VOCs or SVOCs in concentrations exceeding the SRFI Evaluation Criteria. In addition, monitoring well MW-255 contained concentrations of sodium exceeding the SRFI Evaluation Criteria.

AOC 31

One deep monitoring well (MW-250) was installed within AOC 31 (Tank Basin 772 Pump Pad) during the SRFI. This well was paired with a previously installed shallow well (MW-0090) to investigate the hydrogeologic relationships between the first shallow and first native water-bearing zones across AOC 31.

Well Pair MW-0090 and MW-250

Deep well MW-250 was paired with a previously installed shallow well (MW-90) to investigate the hydrogeologic relationships between the first shallow and first native water-bearing zones across the AOI 31 Area.

A downward vertical gradient of 0.01685 was calculated between deep well MW-250 to shallow well MW-0090. Based upon the boring log for MW-250, Clay Horizon A was never encountered; however, red brown clay representing till was intersected at a depth of 12.0 ft. bgs. This clay was not encountered in MW-0090, which was advanced to 14.0 ft. bgs. Based on the evidence of an upward vertical gradient between these wells, and the artesian condition found within deep well MW-250, the till appears to be hydraulically isolating the first shallow water-bearing zone from the first native water-bearing zone in this location.

One deep monitoring well (MW-250) was installed in the Tank 772 vicinity to vertically and horizontally delineate the dissolved phase contaminant plume in this area. Deep monitoring well MW-250 was screened from 29.0 to 34.0 ft. bgs, and was installed to vertically delineate the dissolved phase plume.

Two groundwater samples, M250A1 and M250A2, were collected from MW-250 on February 16 and May 22, 2007, respectively. Both samples were analyzed for VOCs, SVOCs, and metals. Sample M250A1 contained concentrations of VOCs including benzene (180 µg/L) and bromodichloromethane (4 µg/L) in concentrations exceeding the SRFI Evaluation Criteria (1 µg/L for both compounds). Sample M250A2 contained concentrations of VOCs including benzene (5,800 µg/L), cyclohexane (340 µg/L), and methylcyclohexane (140 µg/L) in concentrations exceeding the SRFI Evaluation Criteria (1 µg/L, 100 µg/L, and 100 µg/L, respectively). The most recent groundwater sample collected from MW-0090 (M090B1) on March 29, 2007 contained concentrations of VOCs including benzene (9,200 µg/L), cyclohexane (510 µg/L), and methylcyclohexane (200 µg/L) in concentrations exceeding the SRFI Evaluation Criteria (1 µg/L, 100 µg/L,

and 100 µg/L, respectively). No SVOCs were detected in either MW-0090 or MW-250 in concentrations exceeding the SRFI Evaluation Criteria.

Groundwater from wells MW-0090 and MW-250 contained arsenic and sodium in concentrations above the SRFI Evaluation Criteria. In addition, the last sample analyzed for metals from MW-0090 contained lead and cobalt in concentrations above the SRFI Evaluation Criteria.

Based on the analytical data from MW-250, which indicate the presence of dissolved VOCs in concentrations exceeding the SRFI Evaluation Criteria, an additional investigation across the Tank 772 Area is required to obtain full vertical and horizontal contaminant delineation.

SWMU 8

In 1981, one deep monitoring well was installed east of SWMU 8 (TEL Burial). In 2006, another deep monitoring well (MW-252) was installed within SWMU 8 during the SRFI. These wells were paired with previously installed shallow wells (SB-15 and MW-132, respectively) to investigate the hydrogeologic relationships between the first shallow and first native water-bearing zones across SWMU 8. Shallow well SB-15 is monitored as part of Chevron's Closure Program for the East Yard Basin (EYB). Table 34 and Table 35 provide well construction information for these deep wells.

Well Pair SB-10 and SB-15

Deep monitoring well SB-10 was paired with a previously installed shallow well (SB-15) to investigate the hydrogeologic relationship between the first shallow and first native water-bearing zones across the SWMU 8 Area. For the well pair SB-10 and SB-15, a downward vertical gradient of 0.3889 was calculated between deep well SB-10 to shallow well SB-15. Based upon the boring logs from these well installations, an organic clay/peat layer (Clay Horizon A) is evident at approximately 9.0 to 13.0 ft. bgs beneath the fill layer. No carbon steel casing was installed at deep well SB-10 to isolate the fill from the glacial till layers. It is the only deep well on-site (not including deep piezometers) that was constructed this way. As a result, Chevron decided to install deep well MW-252 during the SRFI at SWMU 8.

Groundwater samples were collected from shallow well SB-15 and analyzed for VOCs, SVOCs, metals, ammonia nitrogen, chloride, nitrate nitrogen, nitrite nitrogen, sulfate, and TDS. Groundwater samples were collected from deep well SB-10 and analyzed for VOCs, SVOCs, metals (only cadmium, chromium, copper, lead, nickel, vanadium, and zinc), ammonia nitrogen, nitrate nitrogen, nitrite nitrogen, and TDS. Table 37 through Table 39 contain a summary of exceedances of the SRFI Evaluation Criteria for all shallow and deep well pairs.

As shown in Table 37, between 2002 and April 2007 (15 sampling rounds), shallow well SB-15 did not exhibit an exceedance of the SRFI Evaluation Criteria for any VOC.

However, well SB-15 has had one SVOCs exceedance of the SRFI Evaluation Criteria (DEHP, 3 µg/L). DEHP was only detected in one of the nine rounds of sampling analyzed for SVOCs since 2002. This occurrence was in October 2003 and the value was 8J µg/L. DEHP has not been detected at well SB-15 in the seven subsequent rounds of sampling including the latest sampling even in April 2007. In addition, shallow well SB-15 has only exhibited concentrations of arsenic, barium, lead, sodium, and thallium exceeding the SRFI Evaluation Criteria. Thallium was only detected once in four sampling rounds and the concentration was 18.5J µg/L in July 2004. During the three subsequent sampling rounds, thallium was not detected.

In contrast, deep well SB-10 was only sampled once in May 2004. No VOCs, SVOCs, or metals concentrations (only cadmium, chromium, copper, lead, nickel, vanadium, and zinc were analyzed) were evident above the SRFI Evaluation Criteria (see Table 37 through Table 39).

Well Pair MW-132 and MW-252

A downward vertical gradient of 0.07407 was calculated, from shallow well MW-132 to deep well MW-252. Based upon the boring logs from the MW-132 and MW-252 installations, both wells intersect a peat horizon (Clay Horizon A), between 12.0 and 15.0 ft. bgs. The evidence of a downward vertical gradient between wells is suggestive of hydraulic interconnectivity between the first shallow water-bearing zone and first native water-bearing zone. However, the continuity of Clay Horizon A in both borings, coupled with the analytical data presented below, indicates that hydraulic isolation between the two water-bearing zones is more likely.

Following groundwater gauging of MW-132 and MW-252, a sample was collected from both monitoring wells and analyzed for VOCs, SVOCs, and metals. Despite possible evidence of hydraulic interconnectivity between water-bearing zones in the MW-132 and MW-252 locations, only sample M132A9 collected on April 11, 2007 contained concentrations of VOCs 1,2-dichloropropane (2J µg/L), benzene (570 µg/L), cyclohexane (290 µg/L), and methylcyclohexane (250 µg/L); and SVOCs 2,4-dimethylphenol (180 µg/L), 2-methylnaphthalene (160 µg/L), and DEHP (14 µg/L) in concentrations exceeding the SRFI Evaluation Criteria. Sample M252A1 from deep well MW-252, collected on February 15, 2007, contained no VOCs or SVOCs in concentrations exceeding the SRFI Evaluation Criteria, providing further evidence of hydraulic isolation between the first shallow water-bearing zone, and the first native water-bearing zone in this vicinity.

Several dissolved metals were detected in samples M132A9 and M252A1 at concentrations exceeding the SRFI Evaluation Criteria (arsenic and sodium) during the most recent sampling events (April 11, 2007 and February 15, 2007 respectively). In addition, sample M132A9 contained lead at a concentration exceeding the SRFI Evaluation Criterion.

Conclusions

Through analysis of the 22 deep monitoring wells and three deep piezometers on-site, Chevron has a better understanding of the vertical hydrogeology of the site. For the first time, a deep groundwater contour map can be generated from site-wide gauging events (see Figure 34). The direction of groundwater flow follows regional projections, east-northeast toward the Woodbridge Creek and the Arthur Kill. The horizontal gradients varied across the NF/MY, from 0.000475 (NF6) to 0.00817 (NF2). In the EY, the horizontal gradients varied from 0.00675 on the western side (AOI 1) to 0.00947 on the eastern side (AOI 2).

The vertical gradients across the site ranged from 0.01063 in the MY NF6 Area (RW-42/MW-239) to 0.6364 in the CY AOC 36 Area (MW-101/MW-184). Seventeen of the 21 shallow/deep well pairs analyzed were calculated to have downward flow. The four remaining well pairs exhibiting upward flow were located in the MY NF2, NF5, and NF6 areas. In contrast, VOCs, SVOCs, and metals were commonly identified in concentrations exceeding the SRFI Evaluation Criteria in the shallow monitoring wells, but the corresponding deep wells did not contain VOC or SVOC exceedances of concern with the exception of AOC 31. The analytical data, coupled with lithologic information from each boring, indicate no evidence of contaminant migration between the first shallow water-bearing zone and first native water-bearing zone across these areas other than AOC 31, despite the number of well pairs calculated to have downward flow.

In summary, vertical delineation of groundwater has been achieved in each of the areas discussed above based upon an analysis of the deep well/shallow well pair data with the exception of AOC 31 (Tank Basin 772 Pump Pad) in the EY Area.

As stated earlier, AOC 31 was an exception to the findings above and contained VOC exceedances in SRFI deep well MW-250. Chevron will pursue this finding and additional nested monitoring well pairs will be installed across the Tank 772 Area in the vicinity of MW-250, to obtain full vertical and horizontal delineation of dissolved phase contaminants at AOC 31.

6.3 Comment 3

RFI Section: General**Comment Letter Page: 1**

Chevron shall present a list of chemicals that would effectively monitor releases from specialized storage, production, and waste disposal units located at the site. For example, the TCL (BTEX in particular) would effectively monitor releases from gasoline storage and production units. However, TCL may not effectively monitor potential releases from naphtha storage areas since petroleum naphtha is composed mainly of hexane and pentane. If there are any areas where samples were not analyzed for the proper chemicals, Chevron shall propose additional sampling and analyses.

Chevron Response

Based on the possible sources on-site, Chevron believes that the current list of analytical parameters is sufficient to monitor releases from specialized storage, production, and waste disposal units located at the site. In 1985, the EPA's Office of Solid Waste developed a list of Appendix VIII Hazardous Constituents applicable to refinery wastes. This list became known as the "Skinner List", and has been used as the basis for many RFIs at refineries. In 1993, EPA's Office of Solid Waste updated the Skinner List by removing some constituents and adding others to the original. Chevron utilized the original and modified Skinner List in developing the list of parameters for its initial investigation program and subsequently expanded the list to include the full TCL list based on NJDEP comments to Chevron's RFI Workplan.

The list of chemicals currently analyzed (as reported by the laboratory) appears sufficient to monitor potential releases from possible sources on-site. Potential sources include operation and storage units associated with asphalt, petroleum hydrocarbons, TEL, naphtha, crude oil, No. 6 bunker oil, diesel fuel, No. 2 fuel oil, and gasoline. The compounds currently being investigated include BTEX (along with other aromatics), PAHs, and cyclic alkanes among others. Library searches are also performed to identify other contaminants which would be extracted and analyzed with the TCL constituents. For example, asphalt compounds include aromatic hydrocarbons, naphthalenes, and PAHs, which are included in the current list of compounds analyzed by VOC and SVOC analysis. Similarly, naphtha monitoring is achieved through the analysis of cyclohexane and methylcyclohexane, and components such as hexane would be identified as a tentatively identified compound (TIC).

See link: <http://www.chem.agilent.com/cag/cabu/pdf/p32.pdf>.

6.4 Comment 4

RFI Section: 6

Comment Letter Page: 1

Arsenic was detected in excess of the NJDEP RDCSCC in approximately 15% of the soil samples collected at the Chevron Refinery site. Chevron states that the elevated arsenic is resulting from either natural background or anthropogenic off-site sources. Therefore, Chevron has concluded that arsenic is not a facility-related chemical. While the NJDEP concurs that natural background concentrations have been found in the State of New Jersey in excess of the 20 ppm RDCSCC, Chevron has not proven this to be the case. The Technical Regulations for Site Remediation provide a mechanism to establish natural background in N.J.A.C. 7:26E-3.10. Should Chevron wish to make the claim that arsenic is natural background, and then appropriate procedures must be implemented. Therefore, Chevron's request to exclude arsenic from the list of site contaminants cannot be accepted at this time.

Chevron Response

In the RFI Report, Chevron discussed that arsenic was found sporadically throughout the Refinery and did not specially correlate well with other petroleum related contaminants found at the facility. As discussed in the Agency's comment, Chevron has previously discussed the known finding that arsenic is a naturally occurring element in many geologic materials. It has been found in significantly elevated concentrations in some natural marine deposits found in New Jersey such as glauconitic sands, where arsenic concentrations can reach as high as approximately 100 ppm. Given the previously discussed sporadic nature of arsenic concentrations and the marine deposits underlying the Chevron site, it appears that some of the arsenic is a component of the natural geologic media at least in part.

Additionally, arsenic in petroleum refinery waste streams occurs at relatively low concentrations when compared to the concentrations found in soils at the site. For example, the Water Resources Research Institute of the University of North Carolina conducted an assessment of typical refinery wastes. The assessment consisted of a number of petroleum solid waste characterizations from which a composite was generated. Results of the composite analysis of the sludge samples yielded 1.3 ppm arsenic. The only Refinery wastes which may contain relatively higher levels of arsenic are "spent hydrotreating catalysts from petroleum refining". These spent hydrotreating catalysts comprised the smallest volume of catalysts used on-site historically. The spent hydrotreating catalysts (including spent fines) were recovered from the Refinery during plant turnarounds, and shipped off-site for metals reclamation.

Therefore, at the time of the RFI, it appeared to Chevron that the sporadically detected elevated levels of arsenic in soils could not be explained by Refinery operations, leaving naturally occurring arsenic as a possible explanation. However, additional analysis of soils conducted in the EY indicates a potential arsenic hot spot and source area. As

shown on Figure 21, significant and consistently elevated arsenic concentrations in soils were found in the southeastern corner of the EY immediately adjacent to the former American Smelting and Refining Company (ASARCO) metal refining facility. Metal refining operations at this facility appear to go back as far as the early 1900s. Metal refining operations at the ASARCO site included tall stacks with air emissions. Currently, arsenic contaminated slag is present on large portions of the former ASARCO site (see Appendix I).

Given the finding of high levels of arsenic in soils in a discrete portion of the EY which appear to extend towards the former ASARCO facility, Chevron will be proposing to conduct an additional investigation, including file reviews, to evaluate this potential source area. Until this task is completed, Chevron will retain arsenic as a potential COC. Accordingly, Chevron has conducted additional arsenic monitoring in soils during the SRFI, and has presented the data in this report.

6.5 Comment 5

RFI Section: 2.3 and 6.1.3

Comment Letter Page: 1

Numerous wastewater discharge points are reported along Woodbridge Creek related to waste management practices prior to 1976. This includes separators, ponds, and mudflats (as further discussed in Section 6.1.3). The locations of these discharges shall be noted on a site map and targeted as part of the surface water and sediment investigation.

Chevron Response

Please see Chevron's response to Comment 147. Additionally, as discussed in Section 9.0 of the RFI Report, the surface water and sediment transects sampled as part of the RFI were selected based on their proximity to the Refinery's current and former surface water discharge points on Woodbridge Creek. The sampling locations were selected in meetings held with the NJDEP and EPA using the available historical aerial photographs and SWMU map, at which both Chevron and the Agencies jointly identified former surface water discharge locations on Woodbridge Creek.

Several of NJDEP's comments concerned the Baseline Ecological Evaluation (BEE), in Section 9.0 of the RFI Report. The BEE focused on surface water and sediments of the tidally flowed water bodies adjacent to the facility. These include the Arthur Kill and the Woodbridge Creek. Most of the watershed in this area has been densely developed for industrial and commercial use over the past century. There is a concentration of industrial uses adjacent to the Arthur Kill, including port facilities and petroleum and chemical industries. The highly industrialized Arthur Kill waterway is dredged to maintain commercial navigation and much of the shoreline is bulk headed or rip rapped. In the past, the Woodbridge Creek was also dredged for industrial and commercial purposes. As discussed in the BEE, these previous conditions in the Arthur Kill and the Woodbridge Creek estuaries resulted in historic, diffuse, anthropogenic contamination of sediments at concentrations greater than natural background, making it difficult to distinguish between potential site and non-site-related contamination. Due to the complexities posed by this environmental setting and the ongoing investigations being conducted by the National Oceanic and Atmospheric Administration (NOAA) and other government organizations, Chevron recommends a meeting with EPA and NJDEP to discuss potential further investigations in these areas.

Chevron's extensive investigation of on-site soil and groundwater conditions indicate that there is no ongoing migration pathway for contamination to reach these surface water bodies from current Refinery conditions. Chevron has installed an extensive monitoring well network along the Refinery's downgradient boundary. This extensive monitoring has confirmed that the groundwater recharging these surface water bodies is not contaminated. Refinery wastewater and stormwater discharges are regulated and monitored in accordance with the facility's NJPDES permit.

Chevron has responded to individual comments on the BEE. However, additional discussion and work plans will be required prior to implementation. Since the ecological investigation is being conducted off-site and is confounded by multiple backgrounds and off-site sources, Chevron proposes to move forward with the RFI approval for the on-site aspects of the project, and to conduct further ecological evaluation as a separate investigation task.

6.6 Comment 6

RFI Section: A.2.1.6, page 129

Comment Letter Page: 1

Chevron concludes in Section 6 (page 129) that vertical and horizontal delineation of soil exceedances of COCs on an area or site-wide basis has been achieved. The NJDEP does not concur with this assessment as it relates to VOCs and metals in SWMA 1. Further delineation is necessary for VOCs (benzene being the primary indicator) and metals (lead being the primary indicator) along the eastern boundary. This is critical due to the proximity of the property boundary.

Chevron Response

During the SRFI, Chevron reviewed all historical soil data in SWMA 1. SWMA 1 is composed of SWMU 27 (TEL Weathering Area), SWMU 29 (Fines Transfer Area), and SWMU 39 (Unnamed NF Pond). No additional soil samples were collected in SWMA 1 during the field portion of the SRFI in the last quarter of 2006 or the first quarter of 2007.

The extent of benzene in soil in SWMA 1 appears to be very limited, with one NJDEP NRDCSCC (13 mg/kg) exceedance at historical boring S1005. Vertical delineation of benzene below the NJDEP NRDCSCC is also evident at this location.

The extent of lead in soil above the NJDEP NRDCSCC (600 mg/kg) is limited and contained within SWMA 1 as seen in Figure 5. Vertical delineation of lead below the NJDEP NRDCSCC is evident at 13.5 to 15.0 ft. bgs at boring locations S0780, S1002, and S1005.

Chevron conducted additional soil sampling activities at SWMU 27 during the CMS to confirm and/or delineate COCs to ensure conditions are understood and contaminants are properly monitored in SWMA 1. These CMS soil samples were analyzed for VOCs, lead, and benzo(a)pyrene. The findings of the CMS will be presented under separate cover.

6.7 Comment 7**RFI Section: A.2.2, 6, page 129****Comment Letter Page: 2**

Chevron concludes in Section 6 (page 129) that vertical and horizontal delineation of soil exceedances of COCs on an area or site-wide basis has been achieved. The NJDEP does not concur with this assessment as it relates to PAHs in SWMA 2. Further delineation is necessary for PAHs (benzo(a)pyrene being the primary indicator) along the eastern boundary. This is critical due to the proximity of the property boundary.

Chevron Response

During the SRFI, Chevron reviewed all historical soil data in SWMA 2. SWMA 2 is composed of SWMU 28 (Reactor Burial), SWMU 30 (Short Term Storage Area), and SWMU 38 (NF Slop Pond). These findings are presented in Figure 7 and indicate that the extent of benzo(a)pyrene above the NJDEP NRDCSCC (0.66 mg/kg) extends across most of SWMA 2 and borders the western boundary of the Chevron property in that area. No additional soil samples were collected in SWMA 2 during the field portion of the SRFI in the last quarter of 2006 and the first quarter of 2007. However, Chevron recently conducted additional soil sampling activities at SWMU 38 as part of the initial phases of the CMS to complete the delineation of (benzo(a)pyrene) and to ensure conditions are understood and contaminants are properly monitored in SWMA 2. The findings of the CMS will be presented in the CMS Preliminary Investigation Report to be submitted to EPA/NJDEP in 2008.

6.8 Comment 8**RFI Section: A.2.3****Comment Letter Page: 2**

Chevron has elected to defer further investigation of SWMA 3 due to the ongoing activities associated with the closure of the North Field Basin (SWMU 1) and Surge Pond (SWMU 2). This is currently acceptable, however Chevron shall provide to the Department a projected timeframe for implementation of the investigation at SWMA 3.

Chevron Response

Chevron conducted an investigation of SWMA 3 during the CMS in 2007. SWMA 3 consists of SWMU 5 (TEL Burial West of the Surge Pond), SWMU 21 (TEL Burial at Mudflats), and SWMU 43 (Mudflats in the NF). The findings of the CMS will be presented in the CMS Preliminary Investigation Report to be submitted to EPA/NJDEP in 2008.

6.9 Comment 9**RFI Section: A.2.7****Comment Letter Page: 2**

The site map for SWMU 7 is difficult to read. There are too many sample points labeled on the map, to the point that the numbers overlap each other and make the map illegible. Chevron shall utilize maps at a greater scale than 1"=50' when the sample points and their labels are too tightly compressed together.

Chevron Response

Chevron has revised Figure A.2.5 to increase the drawing scale to 1" = 40' and make the numbers more legible. Please see attached Figure A.2.5.

6.10 Comment 10**RFI Section: A.2.8****Comment Letter Page: 2**

The discussion on SWMU 16 does not make reference to the significance of the elevated benzene concentrations in soils. Chevron should clarify whether this is related to the LNAPL plume or if there is another source.

Chevron Response

The elevated benzene concentration at SWMU 16 is attributable to the leaded burial site. The sludges that were buried at these locations were from leaded gasoline tanks. Therefore, the presence of benzene is consistent with the waste materials managed at this location.

6.11 Comment 11**RFI Section: A.2.9****Comment Letter Page: 2**

The discussion on SWMU 17 does not make reference to the significance of the elevated benzene concentrations in soils. Chevron should clarify whether this is related to an unknown source.

Chevron Response

The elevated benzene concentrations at SWMU 17 are attributable to the leaded burial site. The sludges that were buried at these locations were from leaded gasoline tanks. Therefore, the presence of benzene is consistent with the waste materials managed at this location.

6.12 Comment 12

RFI Section: A.2.9, and 6, pg. 129

Comment Letter Page: 2

Chevron concludes in Section 6 (page 129) that vertical and horizontal delineation of soil exceedances of COCs on an area or site-wide basis has been achieved. The NJDEP does not concur with this assessment as it relates to VOCs in SWMU 17. Further delineation is necessary for VOCs (benzene being the primary indicator) along the western and northern sides.

Chevron Response

SWMU 17 (TEL Burial East of Tank Basin 301) was investigated during the SRFI as part of AOI NF5. Through the investigation of this area, both vertical and horizontal delineation of VOC soil exceedances have been achieved both in SWMU 17 and across AOI NF5 (benzene being the primary indicator). A description of this work completed during the SRFI in area NF5 is presented in Sections 5.1.4 of this document. SRFI data tables and historical data can be found in Appendix D.

Three SRFI borings were completed around SWMU 17 (S2100, S2126 and S2127). Maximum sample depths from these borings ranged from 10.0 to 20.5 ft. bgs. Two samples were collected at each of these three borings. All six samples exhibited no exceedances of the NJDEP NRDCSCC for VOCs. However, two samples (S2127D2 and S2127E4) did exhibit benzene (8.2 mg/kg and 6.8 mg/kg, respectively) and S2127D2 exhibited xylene (120 mg/kg) concentrations above the RFI Evaluation Criteria (1 mg/kg and 67 mg/kg, respectively) at a depth of 6.5 to 7.0 ft. bgs.

Based on the NJDEP NRDCSCC for benzene (13 mg/kg), the horizontal and vertical extent of contamination is approximately 253 square feet centered on SWMU 17 historical borings S0768 and S0769 as depicted on Figure 16. The vertical extent of benzene contamination is approximately 7 ft. bgs based on SRFI boring S2127 where a peat layer is encountered beneath the fill where the TEL burial is situated. This peat layer and associated clays comprise Clay Horizon A, which acts as a confining layer for the contamination present in NF5. In some cases, peat layers have been known to act as an absorber to certain contaminants.

Based on these findings, SWMU 17 soils require no further investigation and can be addressed by the CMS to determine appropriate and relevant remedial alternatives.

6.13 Comment 13**RFI Section: A.2.10****Comment Letter Page: 3**

The discussion on SWMU 18 does not make reference to the significance of the elevated benzene concentrations in soils. Chevron should clarify whether this is related to an unknown source.

Chevron Response

The elevated benzene concentration at SWMU 18 is attributable to the leaded burial site. The sludges that were buried at this location were from leaded gasoline tanks. Therefore, the presence of benzene is consistent with the waste materials managed at this location.

6.14 Comment 14

RFI Section: A.2.10, and 6, pg. 129

Comment Letter Page: 3

Chevron concludes in Section 6 (page 129) that vertical and horizontal delineation of soil exceedances of COCs on an area or site-wide basis has been achieved. The NJDEP does not concur with this assessment as it relates to VOCs in SWMU 18. Further delineation is necessary for VOCs (benzene being the primary indicator) along the western and southern sides.

Chevron Response

SWMU 18 (TEL Burial West of Tank 301) was investigated during the SRFI as part of AOI NF5. Through the investigation of this AOI, both vertical and horizontal delineation of VOC soil exceedances have been achieved both in SWMU 18 and across AOI NF5 (benzene being the primary indicator). A description of work completed during the SRFI in area NF5 is presented in Section 5.1.4 of this document. SRFI soil data tables and historical soil data can be found in Appendix D.

There are several areas within NF5 containing SRFI and historic borings where benzene was encountered at concentrations above the NJDEP NRDCSCC (13 mg/kg). These areas are sporadic, non-extensive, and vary in size from 36 ft² to 2,768 ft² in aerial extent (see Figure 16).

As depicted on Figure 16, benzene concentrations in soil greater than 13 mg/kg are represented by two blue colored areas north and south of the SWMU 18 TEL burial site. The northern aerial extent of benzene in soil is approximately 1,560 ft². The southern aerial extent of benzene in soil is approximately 2,768 ft². A peat layer was encountered at a depth of 4.0 to 7.5 ft. bgs beneath this area as depicted in Figure 15.A (cross sections c-c' and C-C'). This peat layer and associated clays comprise Clay Horizon A, which acts as a confining layer for the contamination present in NF5 and NF6. In some cases, peat layers have been known to act as an absorber to certain contaminants. These same cross sections (c-c' and C-C') demonstrate the vertical delineation of benzene based on samples collected from SRFI boring S2128 and historical boring S0767 collected in the SWMU 18 area.

Based on these findings, soils at SWMU 18 require no further investigation and can be addressed by the CMS to determine appropriate and relevant remedial alternatives.

6.15 Comment 15**RFI Section: A.2.11****Comment Letter Page: 3**

The site map for SWMU 19 is difficult to read. There are too many sample points labeled on the map, to the point that the numbers overlap each other. Chevron shall utilize maps at a greater scale than 1"=50' when the sample points and their labels are too tightly compressed together.

Chevron Response

Chevron has revised Figure A.2.9 to increase the drawing scale to 1" = 40' and make the numbers more legible. Please see the attached Figure A.2.9.

6.16 Comment 16

RFI Section: A.2.11 and 6, pg. 129

Comment Letter Page: 3

Chevron concludes in Section 6 (page 129) that vertical and horizontal delineation of soil exceedances of COCs on an area or site-wide basis has been achieved. Based on the quality of the site map and other data gaps, it is difficult to verify if this assessment is correct as it relates to VOCs in SWMU 19.

Chevron Response

SWMU 19 was investigated during the SRFI as part of AOI NF3A. Through the investigation of this area, as well as sampling conducted in AOI NF5 (to the east of NF3A), both vertical and horizontal delineation of VOC soil exceedances have been achieved both in SWMU 19 and on a site-wide scale.

Within AOI NF3A, there are four locations (SRFI and historic) where benzene was encountered at concentrations above the NJDEP NRDCSCC (13 mg/kg). These exceedances are sporadic and shallow, with an average depth of approximately 5.0 ft. bgs. Sample S2131G4 is an exception, and was collected from a depth of 13.5 to 14.0 ft. bgs. As shown in Figure 11, when benzene data in this AOI is modeled, areas of benzene concentrations greater than 13 mg/kg occur in the vicinity of S0774 and S2419 (130 ft² and 129 ft² in aerial extent respectively). Areas with benzene concentrations greater than 13 mg/kg at S2139 and S2444 are localized to the vicinity of each boring. Vertical delineation of benzene in this AOI was achieved with samples from both historical and SRFI borings including S0810, S2124, S2136, S2139, S2145, and S2444.

Three borings advanced in NF3A (S2119, S2135, and S2136) are located in the vicinity of SWMU 19. Five samples were collected ranging in depth from 5.5 to 19.5 ft. bgs; however, VOCs were not detected above the NJDEP NRDCSCC in these samples. Figure 10A illustrates that contamination across AOI NF3A has been delineated to approximately 15.0 ft. bgs. A discussion of data from SRFI borings can be found in Section 5.1.2 of this document.

Horizontal delineation of VOCs in NF3A was achieved with both historical and SRFI borings. Borings S0790, S0791, S0844, S2119, S2135, S2137, S2138, S2415, and S2417 provide horizontal delineation for this AOI. In addition, borings S2132, S2133, and S2134 from NF5 further delineate VOCs to the east. The locations of these borings can be found on Figure 11.

During the SRFI, it was found that impacted soils were intermittent across NF3A and were generally encountered immediately above the native peat/organic clay horizon at various depths (3.0 to 12.0 ft. bgs). The petroleum staining and odor terminates abruptly at the peat/organic clay interface, and was not observed penetrating beneath this native material during the investigation. Further discussion of the SRFI investigation of NF3A

can be found in Section 5.1.2 of this document. Data from historical borings can be found in Appendix D.

6.17 Comment 17**RFI Section: A.2.11****Comment Letter Page: 3**

Figure 6-2 defines the limits of exceedances for VOCs based on what appears to be elevated roadways. Chevron should clarify whether this is the justification. Without knowing the source of the soil contamination, it is difficult to conclude that the proposed boundaries are appropriate without clean verification samples outside the limits.

Chevron Response

The basis for the delineation on Figure 6-2 of the 2003 RFI Report referred to by the NJDEP is the placement of tank berms. It is expected that materials released into these basins would be limited in extent by the berm walls.

6.18 Comment 18**RFI Section: A.2.11****Comment Letter Page: 3**

Further delineation may be necessary for VOCs (benzene being the primary indicator) after review of the supplemental information for SMWU 19.

Chevron Response

SWMU 19 was investigated during the SRFI as part of AOI NF3A. Through the investigation of this area, as well as sampling conducted in AOI NF5 (to the east of NF3A), both vertical and horizontal delineation of soil exceedances for VOCs have been achieved both in SWMU 19 and on a site-wide scale. Please see Comment 16 for a full description of the delineation of VOCs at NF3A.

6.19 Comment 19

RFI Section: A.2.12 and 6, pg. 129

Comment Letter Page: 3

Chevron concludes in Section 6 (page 129) that vertical and horizontal delineation of soil exceedances of COCs on an area or site-wide basis has been achieved. The NJDEP cannot concur with this assessment as it relates to lead and TEL/total organic lead (TOL) in SWMU 20. Chevron should verify that the current berm configuration existed at the time the source material was placed in this area. Further delineation may be necessary for lead and TEL/TOL along all sides.

Chevron Response

SWMU 20 was investigated during the SRFI as part of AOI NF3B. Through the investigation of this area, vertical and horizontal delineation of lead and TEL/TOL was achieved at SWMU 20.

During the SRFI, 24 soil borings were advanced to delineate TEL and lead in SWMU 20. Ten samples were collected for TEL. In each case, no TEL was detected in excess of the MDL. Of the forty samples collected for total lead, eight contained concentrations above the NJDEP NRDCSCC of 600 mg/kg. According to the model of lead data generated for NF3B, the one main area in which lead over 600 mg/kg resides is located around Tank 302 on the north and north-west sides of the tank, with an aerial extent of 15,200 ft². A second smaller area of lead contamination greater than 600 mg/kg is located between Tank Basin 302 and Tank Basin 330 with an aerial extent of 614 ft². In addition, two smaller areas are found localized around borings S2447 and S2448 and have aerial extents of 41 ft² and 110 ft² respectively. According to the cross-sections (see Figure 13 and Figure 13A) depicting lead data and XRF data for SWMU 20, the lead contamination does not extend past an elevation of 0 ft. (mean sea level). The contamination is generally shallow, at an average depth of approximately 4.5 ft. bgs with the exception of borings located on elevated berms and roads.

Horizontal delineation of the lead contamination is achieved with samples from borings (starting from the northern portion of the delineation and moving counter clockwise) S2447, S2445, S2555, S2556, S2553, S2557, S2141, S2144, S2449, and S2437. A discussion of data from SRFI borings can be found in Section 5.1.3 of this document.

Although discontinuous across the area, Clay Horizon A is generally encountered at shallow depth (5.0 to 8.0 ft. bgs) in the north-central portion of NF3B (S2440 and S2441), and is encountered at greater depth in an eastward direction (S2436 and S2437). In the southern portion of NF3B, peat is not encountered (S2554 and S2555). In general, the highest lead concentrations at each boring location in NF3B were found at depths between 2.0 and 4.0 ft. bgs, which is within the gray to brown silty sands found at ground surface, and the underlying black silty sands. Lead was encountered at greater depth (7.0 to 9.0 ft. bgs) in borings S2436, S2437, and S2447. This is likely due to the subsequent

addition of road base fill material over these areas. From these findings, Chevron concludes that lead contamination within NF3B is concentrated in the fill and is confined by native materials. Further discussion of data from SRFI borings can be found in Section 5.1.3 of this document.

6.20 Comment 20**RFI Section: A.2.16****Comment Letter Page: 3**

There is no discussion about investigating or delineating contamination that may be associated with the feeder ditch that is located off the southwest corner of the separator footprint. Chevron should clarify this issue.

Chevron Response

The feeder ditch was investigated during the SRFI as part of AOI NF3A. Through the investigation of this area, as well as sampling conducted in AOI NF5 (to the east of the feeder ditch), both vertical and horizontal delineation of soil exceedances for VOCs have been achieved both in the feeder ditch and on a site-wide scale. Please see Comment 12 for a full description of the delineation of VOCs at NF3A and NF5.

Soil borings S2130, S2131, and S2444 were advanced to specifically address contamination associated with the feeder ditch. Boring S2130 was advanced within the feeder ditch according to site drawings and aerial photographs, and boring S2131 was advanced to delineate potential contamination to the east. Samples from these borings were analyzed for TCL VOCs + 10, TCL SVOCs + 20, and TAL metals. Samples collected from S2130 did not contain contaminants in exceedance of the NJDEP NRDCSCC. One sample collected from S2131 (13.5 to 14.0 ft. bgs.) was in exceedance of the NJDEP NRDCSCC for benzene (13 mg/kg). Boring S2444 was advanced in the vicinity of S2131 and vertical delineation for VOCs was achieved with a sample collected from 18.5 to 19.0 ft. bgs. The feeder ditch was delineated horizontally to the east with three borings advanced within NF3A and NF5 (S2124, S2135, and S2137). The feeder ditch was delineated to the west as a portion of AOI NF3A (discussed in Comment 16). A discussion of samples from these locations can be found in Section 5.1.2.

6.21 Comment 21**RFI Section: A.2.17****Comment Letter Page: 3**

Chevron shall explain the relationship of the former surface impoundment (circular structure on Figure 6-14) with the rectangular configuration adjacent to the south of the former surface impoundment. Chevron shall clarify whether this is the oil/water separator.

Chevron Response

The rectangular box depicted on Figure A.2.14 titled SWMU 40 Old Pond is the oil water separator referred to on page A-137 of the RFI report.

6.22 Comment 22

RFI Section: A.2.17

Comment Letter Page: 3

Samples were collected from only one location within the footprint of the former surface impoundment at SWMU 40 and analyzed for full parameters. One additional location was sampled from the rectangular area and analyzed for full parameters. The results from these two locations fail to properly characterize this area. The NJDEP reserves judgment on the appropriateness of moving on to the CMS pending the discussion on the proposed corrective measure for SWMU 40.

Chevron Response

In response, SWMU 40 (Old Pond) was investigated during the SRFI as part of AOI NF6. Through the investigation of this area, both vertical and horizontal delineation of VOC soil exceedances have been achieved both in SWMU 40 and across AOI NF6 (benzene being the primary indicator). A description of the work completed during the SRFI in area NF6 is presented in Sections 5.1.5 of this document. SRFI soil data tables and historical soil data can be found in Appendix D.

In addition to the overall investigation of NF6, SRFI MIP borings S2092, S2094, S2095, S2096, and S2097 were completed north of SWMU 40 to address the horizontal delineation of contaminants at SWMU 40 adjacent to Woodbridge Creek (see Section 5.5). Maximum sample depths from these borings ranged from 20.2 to 30 ft. bgs. These MIP borings were also completed across a historical or paleo-stream channel in the NF that once led to the Woodbridge Creek just to the west of SWMU 40 (see Figure 4). Each of these MIP borings had minimal VOC detections. Based on the confirmatory soil samples from S2097 that exhibited no exceedances for VOCs, they were most likely more reflective of the natural organic material associated with the peat layer in Clay Horizon A. The MIP and corresponding soil confirmation data indicated no concerns or findings that would lead Chevron to install additional groundwater (shallow or deep) monitoring wells or soil borings along SWMU 40 boundary with the Woodbridge Creek.

Based on the NJDEP NRDCSCC for benzene (13 mg/kg), benzene in soil at SWMU 40 has been horizontally delineated as depicted in Figure 16. Historical boring S0803 collected in the center of SWMU 40 indicated a fill/native contact at a depth of 12.0 ft. bgs. This native material consisted of black stained clay with a petroleum odor. As depicted on cross section A-A' on Figure 15.A, soil sample S0803F4 collected at this interval had a benzene concentration of 1.85 mg/kg, which is below the NJDEP NRDCSCC of 13 mg/kg. This interval represents the vertical extent of benzene contamination where Clay Horizon A is encountered beneath the fill layer.

On a side note, soil sample S2097G1 (12.0 to 12.5 ft. bgs) contained an arsenic concentration of 25.7 mg/kg, marginally exceeding the NJDEP NRDCSCC (20 mg/kg). Figure 6 depicts the distribution of arsenic at SWMU 40 and across the NF/MY area.

Based on these findings, SWMU 40 soils require no further investigation under the SRFI and any additional concerns will be addressed by the CMS to determine appropriate and relevant remedial alternatives.

6.23 Comment 23**RFI Section A.2.20****Comment Letter Page: 4**

Chevron has concluded that the Oily Soil Pad (SWMU 51) does not require action per Module III of the HSWA Permit. While that may or may not be true, this potential area of concern does require investigation under the New Jersey Technical Requirements for Site Remediation (7:26E).

Chevron Response

Chevron notes NJDEP's concern over SWMU 51. SWMU 51 is currently under investigation, and Chevron's findings will be presented separately from this report once internal review is completed.

6.24 Comment 24**RFI Section: A.2.25****Comment Letter Page: 4**

Chevron concludes in Section 6 (page 129) that vertical and horizontal delineation of soil exceedances of COCs on an area or site-wide basis has been achieved. The NJDEP does not concur with this assessment as it relates to VOCs and SVOCs in AOC 6A. Chevron should verify that the current berm and road configuration existed during the times that the No. 4 Separator operated. Further delineation may be necessary for VOCs (benzene being the primary indicator) and SVOCs (benzo(a)pyrene being the primary indicator).

Chevron Response

AOC 6A was investigated during the SRFI as part of AOI NF3A. Through the investigation of this area, as well as sampling conducted on the western side of neighboring AOI NF5 (to the east of the feeder ditch), both vertical and horizontal delineation of soil exceedances for VOCs, SVOCs, and metals have been achieved both in AOC 6A and on a site-wide scale. In addition, please see Section 5.1.2 and Comments 16 and 20 for a full description of the delineation of these COCs at NF3A.

The distribution of arsenic, benzo(a)pyrene, and benzene in AOI NF3A and AOC 6A is depicted in Figure 6, Figure 7, and Figure 11, respectively. The delineation of arsenic and benzo(a)pyrene at AOC 6A is represented by the findings around historical borings S0810, S0811, and S0983. In addition, boring S0983 contained the only samples exhibiting benzene collected at AOC 6A. Those results were below the NJDEP NRDCSCC for benzene (13 mg/kg), but above the SRFI Evaluation Criteria (1 mg/kg).

Based on these findings, AOC 6A soils require no further investigation under the SRFI and any additional concerns will be addressed by the CMS to determine appropriate and relevant remedial alternatives.

6.25 Comment 25

RFI Section: A.2.25

Comment Letter Page: 4

The NJDEP is in agreement with the recommendation that AOC 6A be combined with SWMU 35.

Chevron Response

Chevron notes NJDEP's agreement.

6.26 Comment 26**RFI Section: A.2.31****Comment Letter Page: 4**

As previously noted in the Department's review of the Chevron Phase II OWSS Report, the sampling strategy for the Phase II OWSS Investigation was modified to emphasize ground water as the primary media to assess contaminant impact. The Department agreed to this approach due to the random nature of soil contamination associated with miles of pipeline where a potential source is unknown. Ground water is a more accurate indicator of a release in a broad area of concern.

On a number of the investigation areas, significantly high contaminant levels were detected in ground water, indicating a likely source of ground water contamination upgradient of the sample location. Therefore, a soil investigation of the potential source areas must be undertaken and reflected in the recommendation sections of the Report.

These investigation areas include:

MY3 – H0303 (volatiles), H0452 (metals)

NF2 – H0312 (volatiles), H0316 (volatiles), H0458 (benzene)

NF3 – H0319 (volatiles, semi-volatiles, lead), H0458 (benzene)

NF4 – H0324 (benzene), H0423 (benzene)

NF5 – H0325 (volatiles), H0326 (volatiles), H0327 (volatiles), H0328 (lead), H0443 (volatiles)

NF6 – H0442 (lead), H0444 (volatiles), H0465 (volatiles).

Chevron Response**MY3 - H0303 (VOCs), H0452 (Metals)**

MW-133 was installed on August 28, 2002 in the vicinity of H0303, and six consecutive rounds of samples collected from October 6, 2004 through June 11, 2007 have been below the GWQC for VOCs from this well. Chevron believes that VOCs are no longer of concern in this area, but plans to continuing groundwater monitoring at MW-133 as part of the site-wide groundwater sampling program. Please refer to Comment 71 for further discussion of groundwater samples taken from permanent monitoring wells in the vicinity of former temporary well points.

Two borings installed in the vicinity of H0452 were sampled for metals (S0508 and S0955). Soil boring S0508, installed on October 22, 1999 had one sample collected for Skinner Metals from 2.5 to 3.0 ft. bgs. Soil boring S0955, installed on December 2, 2002 had one sample collected for TAL metals from 6.5 to 7.0 ft. bgs. Mercury was detected above the SRFI Evaluation Criteria of 14 mg/kg in sample S0508B2. Results from sample S0955D2 were below the SRFI Evaluation Criteria. Temporary well point H0452 was installed adjacent to the OWSS.

NF2 – H0312 (Volatiles), H0316 (Volatiles), and H0458 (Benzene)

Soil contamination was investigated during the SRFI in the vicinity of H0312, H0316, and H0458 as part of AOI NF2. During this investigation, 22 VOC samples were collected from 10 soil borings. None of these samples contained concentrations of VOCs in excess of the NJDEP NRDCSCC. Sample S2107E1 was collected between 8.0 to 8.5 ft. bgs, and contained concentrations of benzene (1.1 mg/kg) and xylene (68 mg/kg) which exceed the SRFI Evaluation Criteria, but are below current NJDEP NRDCSCC (13 mg/kg, and 1,000 mg/kg, respectively). As shown on Figure 9, the modeled extent of benzene greater than 1 mg/kg in soil is negligible in NF2. Further information about soil sampling in NF2 can be found in Section 5.1.1.

Furthermore, three permanent monitoring wells (MW-240, MW-262, and MW-269) were installed in the vicinity of NF2 during the SRFI and CMS. These wells are currently part of the site-wide groundwater sampling program. MW-240 was sampled once in 2007 and did not have any exceedances of VOCs. MW-262 and MW-269 were sampled twice in 2007. MW-269 had one exceedance for benzene at a concentration of 9 µg/L (second round sample). Chevron believes that soils in this area have been well characterized and will continue sampling the permanent monitoring wells in this area as part of the site-wide groundwater sampling program.

NF3 – H0319 (volatiles, semi-volatiles, lead), and H0458 (benzene)

Soil contamination was investigated during the SRFI in the vicinity of H0319 as part of AOI NF3B. None of the soil samples collected in the NF3B vicinity contained concentrations of VOCs in excess of the NJDEP NRDCSCC. However, soil samples from six boring locations in this area (S2143, S2436, S2440, S2445, S2449, and S2557) did contain concentrations of VOCs in excess of the SRFI Evaluation Criteria. As can be seen in Figure 14, the modeled extent of benzene greater than 1 mg/kg is centralized around the location of SWMU 20. The remainder of benzene in soils greater than 1 mg/kg is sporadic in the investigation area. The black sand and silt with petroleum staining and odor is observed frequently across NF3B at various depths and correlates well with benzene in soils greater than 1 mg/kg. However, this correlation is not consistent across the site. In other areas of the facility, benzene is absent in soil samples collected from black sands, most likely due to weathering. For example, soil sample S2115H4 collected at soil boring S2115 in AOI NF6 did not contain detectable concentrations of benzene, despite being a black sand. The field geologist described sample S2115H4 as a black sand with petroleum staining and a petroleum odor. No SVOCs were detected in concentrations exceeding the SRFI Evaluation Criteria in the four samples analyzed for SVOCs. Of the 40 soil samples analyzed for lead, eleven samples contained lead in concentrations exceeding the SRFI Evaluation Criteria (400 mg/kg). The benzene in soil in this area is well delineated and further information about the SRFI soil investigation at NF3B can be found in Section 5.1.3. Chevron believes that the source of groundwater contamination at NF3 is historical and not from ongoing sources.

Benzene in H0458 was addressed as part of NF2.

NF4/NF5/NF6

H0324, H0325, H0326, H0327, H0423, H0443, H0444, and H0465 are part of a broad area of volatile contamination with multiple sources located in AOIs NF5 and NF6. NF5 and NF6 were investigated as part of the SRFI. Delineation information for soils in these areas can be found in Sections 5.1.4 and 5.1.5. Several locations within the bounds of these AOIs were identified to have impacted soils. Ongoing groundwater monitoring throughout this area coupled with additional wells (deep and shallow) installed during the SRFI provide adequate monitoring of VOCs in groundwater.

In the case of lead in temporary well point H0328, a monitoring well, MW-118, is located in the vicinity of SWMU 6 and H0328. This downgradient monitoring well has been sampled for lead during 10 rounds of groundwater sampling between November 22, 2002 and June 7, 2007. Lead has not been detected during any of these rounds. Chevron believes that groundwater in this area is well characterized and will continue to sample MW-118 as part of the site-wide groundwater program. No further investigation for soil is required for this location.

In the case of lead in temporary well point H0442, a monitoring well, MW-127, was installed at the same location as the temporary well point. Eleven rounds of groundwater sampling were conducted at this location. Lead has not been detected during any of these rounds of groundwater sampling. Chevron believes that groundwater in this area is well characterized and will continue to sample MW-127 as part of the site-wide groundwater program. No further investigation for soil is required for this location.

6.27 Comment 27

RFI Section: A.2.34

Comment Letter Page: 4

Chevron's request for no further action in the aforementioned investigative areas cannot be accepted at this time. Chevron shall address the potential for soil sources of groundwater contamination for each of these areas.

Chevron Response

As stated in the 2003 RFI Report, historical borings in AOC 19 revealed concentrations of benzo(a)pyrene, several other PAHs, and arsenic in samples collected in the fill layer. However, the underlying native soils have not been impacted at this AOC, indicating that soil exceedances have been delineated vertically.

Based on the distribution of arsenic soil exceedances in the MY (see Figure 6), only two occurrences (SB-0189 and S0836) are evident in an isolated area north of Tank Basin 4. Two of the eight samples collected from the subsurface fill layer at AOC 19 contained arsenic (20.8 and 28.0 mg/kg) at concentrations slightly above the NJDEP NRDSCC (20 mg/kg).

Based on the distribution of benzo(a)pyrene soil exceedances in the MY (see Figure 7), four of the eight subsurface fill samples contained benzo(a)pyrene and several other PAHs at concentrations above the NJDEP NRDCSCC (e.g., 0.66 mg/kg for benzo(a)pyrene). Benzo(a)pyrene was present in all four of these samples, and at a maximum concentration of 27 mg/kg in sample S0837C4 (5.5 to 6.0 ft. bgs). This sample was collected in the AOC 19 LNAPL Area and also exhibited black staining and odor, and contained catalyst beads. Fingerprint analysis of sample SB0189 indicated that No. 2 fuel oil was present in that sample. The other three samples were collected further west and north of Tank Basin 4.

Groundwater

In the vicinity of AOC 19, 22 temporary well points and six permanent monitoring wells exist to monitor groundwater quality and the hydrogeology. As depicted on Figure 37, of all the temporary well points installed in the area of AOC 19, only two have had marginal exceedances of benzene (H0220 at 4 µg/L and H0302 at 2 µg/L) and one exceedance at H0303 of 910 µg/L. However, permanent well MW-133 was installed adjacent to temporary well H0303 in 2002 and indicated an estimated benzene concentration of 2J µg/L. However, benzene has not been detected in all subsequent groundwater samples (5 rounds). For further information about temporary well point results in comparison with monitoring well results see Comment 71.

Of the other five permanent monitoring wells in the vicinity of AOC 19, downgradient permanent well MW-128 has had a history of random benzene exceedances ranging from

73 µg/L in 2004 to 3J µg/L in 2006. Otherwise, benzene was not detected in concentrations above the MDL in five of eight sample rounds since 2002.

Permanent monitoring well MW-154 is located in the vicinity of the soil exhibiting arsenic exceedances at AOC 19, as described earlier. Of the rounds of samples analyzed for arsenic, two of the three exhibited exceedances of the NJDEP GWQC (3 µg/L). These exceedances ranged from 8.4 µg/L in January 2003 to 7.2J µg/L in September 2003. Downgradient well MW-139 has exhibited three exceedances (in 2002, 2003, and 2004) over the past eight sampling rounds; however, arsenic was not detected in the last four sampling rounds (2005 and 2006). These exceedances ranged from 6J µg/L to 10 µg/L.

There have been no SVOC exceedances in wells MW-128, MW-133, MW-137, MW-139, or MW-154 at AOC 19.

In the November 2003 RFI Report, Chevron indicated that AOC 19 would be included for further evaluation in the CMS. During the CMS in the NF/MY Area, only two locations were sampled, and they were confined to the AOC 19 LNAPL Area (see Figure 3).

6.28 Comment 28**RFI Section: A.2.37****Comment Letter Page: 4**

Figure A.2.33 fails to identify the location of boring S0863. Chevron should clarify if it was installed in the same location as MW-154. In addition, the figure must identify the limits of the soil excavation that occurred when the release was first discovered. Chevron should clarify how the limits of excavation compare to the location of boring S0863.

Any action regarding the request for no further action at AOC 24 will be deferred until the above information is provided and reviewed.

Chevron Response

Monitoring well MW-154 was placed in the same location as boring S0863. Chevron has revised Figure A.2.33 to include the location of S0863 and the limits of the soil excavation. The scale of the drawing has also been increased to 1" = 40'. Please see the attached Figure A.2.33.

6.29 Comment 29**RFI Section: A.2.38****Comment Letter Page: 5**

Due to the potential for vapor intrusion from the elevated benzene contamination in ground water, Chevron shall identify the two buildings adjacent to Tank 314. Further investigation of this pathway (as generally discussed below) appears to be warranted.

Chevron Response

RFI Figure 2-2 incorrectly identifies two structures adjacent to Tank 314 as buildings. The structures immediately to the east of Tank 314 are concrete basins remaining from the former No. 1 Cooling Water Tower. Figure 2-2 has been revised such that these basins are no longer designated as buildings (please see attached Figure 2-2).

6.30 Comment 30**RFI Section: A.3.1****Comment Letter Page: 5**

As previously stated, the site map (Figure 2-2) identifying the SWMUs and AOCs shall be modified to differentiate SWMU 11A and SWMU 11B. Currently, the site maps label them as SWMU 11 and SWMU 11(2). Consistency in the alphanumeric designation would alleviate some of the confusion regarding SWMU 11.

Chevron Response

SWMU 11 and SWMU 11(2) on RFI Figure 2-2 have been revised as SWMU 11A and SWMU 11B, respectively. Please see Comment 29 response for the revised figure.

6.31 Comment 31

RFI Section: A.3.7**Comment Letter Page: 5**

Chevron concludes in Section 6 (page 129) that vertical and horizontal delineation of soil exceedances of COCs on an area or site-wide basis has been achieved. The NJDEP does not concur with this assessment as it relates to SVOCs in SWMU 34.

The analytical results for boring S1432 reveal elevated concentrations for benzo(a)pyrene (9.3 ppm) at the intermediate depth. Since this sample is located along the property boundary, further delineation is necessary for SVOCs (benzo(a)pyrene being the primary indicator).

Chevron Response

During the RFI, three samples were taken from boring S1432. The deepest sample (S1432J3) was collected at a depth of 19.0 to 19.5 ft. bgs and was non-detect for benzo(a)pyrene. Horizontal delineation to the north, south, and west has been completed as part of the SWMU 34 investigation (see Figure 7). Due to access constraints, additional samples were not taken to the east. The Conrail rail line is immediately to the east of S1432. This is an active freight rail line. Chevron believes that delineation to the east of S1432 can be inferred from the historical use of the area. As discussed in Chevron's October 2001 Full RCRA Facility Investigation Workplan, (see Section 6.2.7 SWMU 34), the elevation of this area was raised by over 10 feet through filling to build Chevron's rail siding loading rack. The contamination is coincident with the fill. Its eastern horizontal boundary can reasonably be assumed to be Chevron's property boundary with Conrail. Chevron is proposing that the extent of the soil contamination at S1432 be extended to end at the property boundary.

6.32 Comment 32**RFI Section: A.4.2****Comment Letter Page: 5**

Chevron concludes in Section 6 (page 129) that vertical and horizontal delineation of soil exceedances of COCs on an area or site-wide basis has been achieved. The NJDEP does not concur with this assessment as it relates to VOCs in SWMU 8.

The analytical results for numerous borings reveal elevated concentrations for benzene at the intermediate depth. Since these samples are located along the property boundary, further delineation is necessary for VOCs (benzene being the primary indicator).

Chevron Response

Delineation of SWMU 8 has been sufficiently completed to confirm its inclusion in the CMS and to allow for the development/analysis of remedial alternatives. Supplemental delineation is planned for this area in order to compile data inputs needed for corrective measures design and will be presented in the CMS Preliminary Design Investigation (PDI) Report.

6.33 Comment 33**RFI Section: A.4.4****Comment Letter Page: 5**

Chevron concludes in Section 6 (page 129) that vertical and horizontal delineation of soil exceedances of COCs on an area or site-wide basis has been achieved. The NJDEP does not concur with this assessment as it relates to volatile organic compounds (VOCs) and metals in SWMU 10. Further delineation is necessary for VOCs (benzene being the primary indicator) and metals (lead and TOL/TEL being the primary indicators) primarily in the Tank 767 berm area.

Chevron Response

SWMU 10 was investigated during the SRFI and CMS (soil and groundwater). During the SRFI, permanent deep monitoring well MW-242 was installed (see Comment 2). However, no soil samples were collected during the SRFI. During the CMS PDI, several soil samples were collected for delineation purposes. The findings of this separate investigation will be presented in the CMS PDI Report.

6.34 Comment 34

RFI Comment: A.4.14**Comment Letter Page: 5**

Chevron concludes in Section 6 (page 129) that vertical and horizontal delineation of soil exceedances of COCs on an area or site-wide basis has been achieved. The NJDEP does not concur with this assessment as it relates to VOCs in AOC 14. The analytical results for numerous borings reveal elevated concentrations for benzene at the intermediate depth. Thus, further delineation is necessary for VOCs (benzene being the primary indicator).

Chevron Response

AOC 14 was investigated during the SRFI as part of AOI 2. Through the investigation of this area, both vertical and horizontal delineation of soil exceedances for VOCs have been achieved, both in AOC 14 and on a site-wide scale (benzene being the primary indicator).

Within AOI 2, there are six locations (SRFI and historic) where benzene was encountered at concentrations above the NJDEP NRDCSCC (13 mg/kg). The benzene exceedances in soil are located south of the extent of the AOC 14 boundary, bounded on the east by the sheet piling at #3 Berth and to the west and south by Wharf Avenue (see Figure 26). Benzene is found above 13 mg/kg at borings S0498 and S2325 in an area with an aerial extent of approximately 400 ft²; at borings SB-0003, SB-0010, S0853, and S2138 with an aerial extent of 800 ft²; at SB-0002 with an aerial extent of approximately 800 ft²; at SB-0004 with an aerial extent of 100 ft²; at S0497 with an aerial extent of 100 ft²; and in the immediate vicinity of boring SB-0001. Within these six areas, the contamination is contained within a zone approximately 2.0 to 6.0 ft. bgs (see Figure 24.A).

As described in Section 5.2.2, the native material, a dark brown peat underlain by red brown silty clay, was encountered at AOI 2 in SRFI borings between 12.0 and 30.0 ft. bgs. The black sand was generally observed with petroleum odor and staining, occasionally with weathered petroleum product, and was discontinuous across AOI 2. Although discontinuous across the area, the peat is generally encountered at a greater depth in an easterly direction. At S2321, peat was encountered between 9.5 and 10.0 ft. bgs. At S2327, located approximately 360 feet to the east of S2321, peat was encountered between 12.6 and 14.5 ft. bgs. At S2318, located approximately 160 feet eastward of S2327, peat was encountered between 22.0 and 24.0 ft. bgs. Chevron maintains that the peat and silty clay act as a confining layer in AOI 2 and clean vertical samples (S2317H4, S2325H2, and S2326G1) collected during the SRFI, as described in Section 5.2.2 and presented in Figure 24.A, verify this.

6.35 Comment 35**RFI Section: A.4.14****Comment Letter Page: 5**

In addition, Chevron recommends that AOC 14 be incorporated into EY4B LNAPL area and removed from the AOC list. The soil contamination associated with AOC 14 represents a source of ground water contamination. Therefore, the NJDEP cannot concur with Chevron's proposal to terminate the AOC designation.

Chevron Response

Chevron acknowledges NJDEP's comment. Based on the SRFI, AOC 14 (GWQAP Oily Fill Area III) will continue to be designated as an AOC. However, due to the geographical overlap and the potential for commingling, Chevron feels that for the purposes of investigation and remediation, it is important to address some areas of contamination as a single unit. Therefore, while these units may retain their individual designations, Chevron viewed them as one physical unit (AOI 2) with multiple potential contaminant sources (see Section 5.2.2) during the SRFI. In addition, please see Comment 34.

6.36 Comment 36**RFI Section: A.4.16****Comment Letter Page: 6**

Chevron previously suggested that the source of the oily petroleum material was oily fill used historically in the East Yard. Based on this, Chevron is proposing to investigate this AOC as part of the LNAPL plume delineation.

Chevron shall be aware that soil contamination must be fully delineated. There are no soil samples collected on the western side of Wharf Avenue, where the two bunker slabs were located. Chevron shall address this issue.

Chevron Response

See the response to Comment 34.

6.37 Comment 37

RFI Section: A.4.16

Comment Letter Page: 6

The 1st Phase RFI Soils Report recommended the development and implementation of a regional (eastern portion of the East Yard) assessment of the distribution of historic oily fill. Chevron should clarify whether this approach has been considered.

Chevron Response

Chevron is currently in the process of developing a three-dimensional geologic model of the site to be submitted to EPA/NJDEP in 2008 as a separate deliverable. The geologic model will include local stratigraphy as well as soil types, including the identification and description of fill based on Chevron's boring log database.

6.38 Comment 38**RFI Section: 8****Comment Letter Page: 6**

Chevron shall evaluate the vapor intrusion pathway within the site. The assessment shall be consistent with the USEPA's Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway for Groundwater and Soils (November 2002). This provision is required for all RCRA sites in order to determine whether the vapor intrusion pathway is complete. It should be noted that Chevron shall evaluate both current and future use scenarios in determining whether the pathway is complete.

If a determination is made that the pathway is complete, a supplemental workplan shall be prepared to properly investigate the potential migration of subsurface vapors from contaminated ground water and/or soils.

Chevron Response

Chevron has reviewed USEPA's Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway for Groundwater and Soils (Subsurface Vapor Intrusion Guidance) (2002). The intent of this draft guidance is to provide a tool to help the user conduct a screening evaluation as to whether or not the vapor intrusion exposure pathway is complete and, if so, whether it poses an unacceptable risk to human health. The draft guidance is primarily designed to ensure protection of the public in residential settings.

There are three tiers of assessment in the document that involve increasing levels of complexity and specificity:

- Tier 1 - Primary Screening is designed to be used with general knowledge of a site and the chemicals known or reasonably suspected to be present in the subsurface; it does not call for specific media concentration measurements for each constituent of concern;
- Tier 2 - Secondary Screening is designed to be used with some limited site specific information about the contamination source and subsurface conditions (e.g., measured or reasonably estimated concentrations of target chemicals in groundwater or soil gas, and depth of contamination and soil type); and
- Tier 3 - Site-Specific Pathway Assessment involves collecting more detailed site specific information and conducting confirmatory subslab and/or indoor air sampling.

Chevron has completed a Tier 1 and applicable portions of a Tier 2 type assessment for the Refinery as described below.

Current and Potential Future Site Use and Potential for Human Exposure

As discussed previously in Chevron's RFI (2003), the Refinery is an active, industrial facility located in a heavily industrial area within the city of Perth Amboy, Middlesex County, New Jersey. The facility has been in operation since 1920. Barber Asphalt Company built and operated an asphalt refinery in 1920. The California Oil Company (which later became Chevron) purchased the property in 1946 and expanded the Perth Amboy facility into a full service refinery in 1950. In 1983, Chevron shut down several process units and scaled back the Refinery operation to asphalt topping. Chevron continues to operate the facility today. The facility consists of tankfields, an asphalt distribution terminal, process areas, offices, mechanical shops, wastewater treatment units, pipelines, and tanker docks.

The Refinery has traditionally been divided into six major geographical areas referred to as AF, the WY, the CY, the NF/MY, the EY and the NFE (see Figure 3).

AF and the WY have recently been sold by Chevron as part of Perth Amboy's redevelopment project for this part of the city. Prior to being sold, all structures were demolished and both AF and the WY were cleaned up in accordance with NJDEP oversight. Remediation of these two parcels was conducted in accordance with two Memoranda of Agreement issued pursuant to N.J.A.C. 7:26C. Petroleum contaminated soil in both AF and the WY has been excavated and removed from the site. Metal contaminated soil in the WY has been excavated and placed under new buildings and have been deed restricted. Both parcels are commercial/industrial. Redevelopment of the former WY was completed with the construction of a warehouse operation by the new property owner. The redevelopment of AF is almost complete; a new warehouse is in the final stages of construction by the new property owner. The NFE is a vacant tract of land separated from the Refinery by Woodbridge Creek. The NFE has not been developed or used by Chevron for any industrial/commercial purposes. Therefore, AF, the WY, and the NFE do not present a potential indoor air exposure pathway of concern.

The remainder of the Refinery includes the CY, the NF/MY, and the EY. These areas comprise the active yards of the Refinery. The EY is comprised of above ground petroleum storage tanks, a loading rack, and the Refinery dock. The CY is comprised of above ground petroleum storage tanks, rail siding, and environmental staff trailers. The NF/MY is comprised of the petroleum asphalt refining units (crude unit and flares), refinery operations and administrative buildings, and the ETP. None of the occupied buildings have basements.

The entire Refinery is fenced, gated with manned video surveillance, and patrolled 24 hours a day, 365 days per year. All gates are locked and under continuous control by manned guard houses. The general public is not allowed into the Refinery. The Refinery staff and contractors are health and safety trained. The Refinery staff work 40 hour work weeks, with additional time off for holiday and vacation.

Subsurface contamination at the Refinery has been characterized through various phases of the RFI. Exposure to contaminated areas is controlled through the Refinery's in-house permit to work program. Refinery staff or contractors planning excavation, construction and similar types of disturbance activities are required to obtain an in-house permit approval prior to commencing work. Contaminated areas are identified and appropriate protective methods, including the use of personal protective equipment when appropriate, must be employed in order to obtain a permit. The Chevron lead unit operator is authorized to issue permits and is OSHA HAZWOPER and Chevron trained.

In summary, the facility has strict public access controls, stringent health and safety procedures, and is staffed by highly trained personnel who are aware of the presence of petroleum constituents. The facility is and is expected to remain an industrial site.

In 2005 USEPA Region 2 reviewed the potential human exposure pathways, including indoor air exposure, at the Refinery as part of the RCRA Environmental Indicator Program (also known as RCRA EI CA 725) and determined that current human exposure is "Under Control". A copy of the EI can be found at USEPA's web site at http://www.epa.gov/region02/waste/chev_p725.pdf.

Subsurface Source Identification

As discussed in detail in the RFI and SRFI, both soil and groundwater quality have been extensively investigated at the facility. Hundreds of groundwater and soil samples have been taken and analyzed throughout the facility. The areas investigated included SWMUs and AOCs identified in the HSWA permit as having a potential for a release, PAOCs, LNAPL areas, surface water bodies, and wetlands around the perimeter of the site. Where releases were identified, the nature and extent as well as whether groundwater at the facility was affected by the releases were evaluated. The Full RFI Report was submitted to the USEPA and NJDEP in November, 2003. Subsequent investigations, including this SRFI have also been completed.

Subsurface contamination is primarily comprised of petroleum related constituents and other refinery related constituents. These include VOCs, PAHs, and various metals. In some areas petroleum LNAPL has been found in the subsurface. From a potential vapor intrusion standpoint, benzene has been identified as the COC for evaluation of the potential vapor intrusion pathway. As discussed in both the RFI and SRFI, benzene is the most frequently and widespread detected groundwater and soil contaminant at the site. It is classified as a known human carcinogen and is sufficiently volatile (see Table 1: Question 1 Summary Sheet of the draft Subsurface Vapor Intrusion Guidance). As provided in NJDEP's Vapor Intrusion Guidance Document (2005c), the chemical properties of benzene are provided in Table 40.

NJDEP's Vapor Intrusion Guidance Document uses a benzene screening level in groundwater of 15 µg/L to evaluate the potential indoor vapor intrusion pathway from groundwater (NJDEP, 2007). USEPA uses a range of values as high as 140 µg/L to evaluate the potential indoor vapor intrusion pathway from groundwater (USEPA, 2002).

Table 40. Properties of Benzene

Organic Carbon Partition Coefficient K_{oc} (cm ³ /g)	Diffusivity In Air (cm ² /s)	Diffusivity In Water (cm ² /s)	Pure Component Water Solubility (mg/L)	Henry's Law Constant	Boiling Point (°K)	Enthalpy Of Vaporization At Normal Boiling Point (cal/mol)
5.89E+01	8.80E-02	9.80E-06	1.79E+03	2.27E-01	353.24	7,342

These values are generic and include many conservative assumptions, primary of which is that of a residential exposure frequency. The use of a residential exposure frequency in this case is unnecessarily conservative. However, for the purpose of this initial screening, Chevron used the NJDEP's 15 µg/L benzene in groundwater guideline. Additionally, Chevron included the presence of LNAPL as an initial screening criterion.

The distribution of benzene in groundwater throughout the Refinery is discussed in Sections 5.3 and 5.4 of this SRFI and shown on Figure 37. The benzene plume is well defined and stable. As summarized on Figure 37 the vast majority of the areas encompassed by the plume have benzene concentrations below 10 µg/L.

A total of 17 LNAPL areas have been identified and delineated at the Refinery and are shown on Figure 41. A description of the LNAPL areas are provided in Section 7 of the Full RFI Report (Chevron, 2003). Depending on their location, the LNAPL areas are comprised of various petroleum products ranging from heavily weathered petroleum materials with little volatile organic components remaining, to less weathered lighter end petroleum. Those LNAPL areas comprised of less weathered lighter end petroleum materials are frequently coincident with the higher concentration benzene plumes at the site. In these instances, the LNAPL itself is the likely source of the high dissolved phase benzene concentrations in groundwater.

Occupied Structures in Relation to Contaminated Groundwater

The occupied structures at the site include:

- Administrative offices and Refinery control offices located in the MY;
- Three guard houses; one at the entrance to the MY, one at the entrance to the EY, and one at the entrance to the NF/MY;
- ETP control room;
- Wharf/dock area control building near the dock in the EY;
- CEMC office trailers in the CY;
- Maintenance building in the EY; and
- The crude unit in the MY.

As part of the vapor intrusion pathway screening, all of these structures were evaluated to determine if they overlie areas of the benzene plume exceeding 15 µg/L or an LNAPL

area. Only one of structures, the CEMC office trailers in the CY met this criteria for further evaluation. As can be seen on Figure 37, a benzene plume exceeding 15 µg/L and an LNAPL plume exist immediately adjacent to the trailers.

These trailers were further evaluated to determine if a potential vapor intrusion pathway likely exists. All of the trailers are located approximately four feet above the ground surface and are supported by jacking. There is no direct connection between the trailers and the ground. The crawl space beneath the trailers is open, allowing open air movement. Therefore, a likely vapor intrusion pathway does not exist.

Conclusions

Based on the foregoing analysis of subsurface contamination, and current and potential site use, a potential vapor intrusion pathway does not exist at the Refinery. The site is an active petroleum facility and is anticipated to remain industrial. Subsurface contamination is well defined. Access to the facility is completely controlled to prevent the general public or trespassers from entry. No further analysis is recommended.

6.39 Comment 39**RFI Section: Figure 2-2****Comment Letter Page: 6**

The site map for the Chevron Perth Amboy site appears to incorrectly label a block along State Street as part of the site. In fact, this is a commercial/residential strip bordering Garretson Avenue and is not part of the site. The site map should be modified.

Chevron Response

The State Street properties have been removed from Figure 2-2 to avoid confusion. It was not Chevron's intention to include them as Refinery property on the map. Please see the response to Comment 29 for the revised figure.

6.40 Comment 40**RFI Section: 8 and 4.1.2, page 38****Comment Letter Page: 6**

Chevron indicates that they are utilizing a combination of low flow and three volume purging techniques to obtain more representative data from monitor wells. Chevron indicates that the change was made due to the minimal amount of water drawn from the well during low flow sampling. Chevron indicates that based on the minimal amount of water drawn from each well, the sample water may still contain some small percentage of original well volume water, which may not be representative of volatile or semi-volatile organic constituents. Chevron should be advised that the Department has noted instances where monitor well and hydropunch groundwater sampling data are not comparable. This may be caused by sampling error and is discussed further below. Chevron shall determine the best method for sampling wells at their site and submit a revised sampling SOP to the Department for approval. If Chevron plans to attempt low flow purge and sample techniques in the future, the method shall conform to the Department's "Low Flow Sampling Guidance" at <http://www.nj.gov/dep/srp/guidance/lowflow>.

With regard to low yielding wells, the guidance states the following:

Low Flow Purging and Sampling for Low Yielding Wells

Wells that yield less than 0.1 l/min (100 ml/min) frequently incur significant drawdown during well purging. If drawdown occurs across the screened interval or open borehole of a well, VOC loss may result. The increased stress on a well caused by significant drawdown may also result in an increase in water turbidity. In an effort to facilitate the collection of a representative groundwater sample from low-yielding wells, the NJDEP will allow special sampling procedures to be used. This may include sample collection without regard to monitoring Water Quality Indicator Parameters (WQIPs) associated with well stabilization.

At a minimum, water-quality data, well-construction data, water-level data, and accurate well-yield data for each low yielding well will need to be submitted to the Department prior to the development of an acceptable sampling procedure. Since sample collection may begin almost as soon as purging is initiated, it is imperative that the exact interval where the sample will be collected along the screen be predetermined. Aside from the considerations for monitoring drawdown and WQIPs, all other Low Flow Purging and sampling considerations discussed above apply here as well. The owner of the well shall also propose possible explanations for the low yield of the well(s). Once the aforementioned information has been received, the Department will work with the well owner to formulate an acceptable sampling plan. The sampling plans will be approved on a case-by-case basis and will be well specific. Implementation of any special sampling procedure or use of any special sampling equipment shall not be performed without prior NJDEP approval.

Chevron Response

Prior to 2002, Chevron had sampled monitoring wells utilizing a low-flow groundwater sampling protocol described in the February 6, 1998 *Addendum to Approved SAP/QAPP*. The Addendum was accepted in NJDEP's March 25, 1998 letter to Andrew Park, EPA. In 2002, Chevron modified this procedure to help account for lower water tables and declining well yields related to drought conditions, as well as for those wells that are naturally low-yielding due to hydrogeological conditions on site. This modification entailed the use of the low-flow groundwater sampling protocol only for the collection of metals samples and the use of the three-well volume purge/bailer method for all other parameters (e.g., VOCs, SVOCs, etc.).

To begin the sampling process, low-flow purging is conducted using a peristaltic pump set at a pumping rate of 100 ml/min. and dedicated tubing. This pump rate is consistent with procedures described in USEPA Region II's Groundwater Sampling Procedure Low Stress (Low Flow) Purging and Sampling methodology (USEPA, 1998), and the above-mentioned Addendum. Prior to this sampling procedure modification, low-flow purge rates were set so as to not cause draw-downs of more than 0.25 feet. However, these very low rates sometimes affected field/geochemical parameter measurements (pH, dissolved oxygen, etc.) and resulted in very long sampling times. The use of the 100 ml/min. pumping rate does cause a drawdown of more than 0.25 feet in a limited number of wells, but provides for much more representative measurements of field parameters.

Geochemical parameters are measured using a Horiba U-22 water quality meter with in-line, flow through cell. Low-flow purging is performed until geochemical parameters have stabilized for three successive two-minute intervals after a minimum of 25 minutes. A metals sample is then collected directly from the pump discharge into laboratory supplied bottleware. Again, only metals samples are collected using the low-flow sampling technique. VOCs and other parameters are collected using the method described below.

After the metals sample has been collected, the well is purged of three well volumes of water using a peristaltic pump. Changing groundwater levels and constituent patterns often preclude sampling at a discrete interval during every sample event. Therefore, for consistency, pump intake tubing is always placed in the middle of the water column and adjusted as necessary during purging. Samples are then taken for organic analysis (VOCs, SVOCs, nitrate, nitrite, ammonia, etc.). A dedicated polyethylene bailer is used to collect these samples, and care is taken to impose a minimum of aeration/agitation to the sample. This change in purge techniques was made primarily due to the minimal amount of water drawn from the well during low flow sampling. The low flow technique allowed for a sample to be obtained with minimal turbidity and subsequently more representative metals data. However, as described in Section 4 of the Full RFI Report, the minimal amount of water drawn from each well may not be enough to purge the water column of the original well volume water, which may not be representative of VOCs or SVOCs due to natural volatilization in the well prior to sampling. In addition, the

vacuum induced by the peristaltic pump may cause volatilization of VOC constituents, and sample tubing may adsorb or desorb organic compounds.

Chevron has described this modified groundwater sampling procedure in various documents submitted for approval to NJDEP and EPA, including the Annual West Yard Groundwater Monitoring Report (2003a), and the NF/MY SRFI DWP (2006b).

Chevron does not believe that this sampling method is responsible for the disparity between temporary well point and permanent monitoring well sample data. Please refer to Comment 71 for a discussion of temporary well point versus permanent monitoring wells at the Perth Amboy, NJ Refinery. At this time, Chevron believes that continued sampling utilizing the current low-flow/three-volume purge combination will provide consistent and representative sample results.

6.41 Comment 41**RFI Section: 7****Comment Letter Page: 7**

For each LNAPL area, Chevron shall submit an evaluation of potential preferential pathways for contaminant migration. These include subsurface piping, heterogeneous fill etc. If potential preferential pathways exist near an LNAPL area, the pathway shall be investigated to determine if LNAPL or dissolved ground water contaminants are migrating along or through the identified pathway to assure that delineation has been completed.

Chevron Response

Chevron believes potential preferential pathways for contaminant migration have been adequately investigated. The OWSS is the primary underground piping system in the Refinery which could serve as a potential preferential pathway. The OWSS was evaluated and investigated during the Phase I and Phase II OWSS investigation. The purpose of the OWSS investigations was to evaluate whether there were environmental impacts from the OWSS. During the Phase I and Phase II investigations, more than 75 soil samples and 250 groundwater samples were collected in close proximity to the OWSS lines in the MY/NF, EY and CY. In addition, LNAPL and dissolved phase contamination identified during the OWSS investigation were further investigated and delineated as part of the LNAPL Management Program and the Full RFI Investigation. Therefore, the OWSS has been appropriately investigated and LNAPL or dissolved phase groundwater contaminants migrating along the OWSS have been identified and investigated.

As stated in the September 2002 LNAPL Management Plan and November 2003 Full RFI Report, boring logs from soil borings and monitoring wells used to delineate LNAPL indicate the fill material is heterogeneous and consists of discontinuous layers and lenses of flyash, catalyst beads and construction debris. These more permeable, discontinuous layers and lenses were placed during various periods of filling and are surrounded by lower permeability clays which are typical of the fill material at the site. LNAPL at the site is highly weathered and typical accumulations of LNAPL are less than 0.01 feet in source area monitoring wells located within the discontinuous, more permeable materials. These isolated layers and lenses are often depleted rapidly during LNAPL recovery measures. Based on the age and small apparent thickness, the LNAPL in the subsurface appears to be immobile. Due to the isolated and discontinuous nature of the more permeable lenses in which LNAPL is typically found and the immobility of the LNAPL at the site, Chevron does not believe LNAPL or dissolved phase contaminants are migrating through the heterogeneous fill material. In addition, the LNAPL areas have been thoroughly investigated and delineated as part of the LNAPL Management Program and therefore, no additional investigation is warranted at this time.

6.42 Comment 42**RFI Section: 7****Comment Letter Page: 7**

Chevron shall submit a table with the following column headings: MW ID, northing, easting, elevation top of casing, depth to ground water, elevation ground water, depth to top of screen, screen length, elevation top of screen. If any monitor wells intended for the purpose of monitoring LNAPL are not screened across the water table, Chevron shall replace them with properly screened wells.

Chevron Response

Chevron acknowledges the Department's comment and has provided the information requested in Table 41. The groundwater measurements in Table 41 were recorded during the most recent site-wide gauging event on February 21, 2007. As shown on the table, groundwater was measured above the screened interval in MW-0029 located at SWMU 43 and in MW-234, NF-11, and RW-35 located in low lying areas such as tank basins. Chevron believes a higher groundwater table is present in these areas because of a sheet pile wall at SWMU 43, which altered the ground surface and water table in the low lying areas. In cases where groundwater was found to be higher than the screened interval, Chevron has provided measurements from alternate gauging events where groundwater was measured within the screened interval and if present, LNAPL would have been identified. In addition, during semi-annual and quarterly groundwater sampling events, these wells are purged, which would also allow for the identification of LNAPL if present. Furthermore, LNAPL has been detected in MW-0029, MW-234, and RW-35 when groundwater was observed above the screen, indicating these wells remain useful for LNAPL monitoring. As such, Chevron does not believe any of these wells warrant reinstallation.

Table 41. LNAPL Monitoring Wells and Piezometers

Well ID	Northing	Easting	Screen Int. (ft. bgs)	Screen Length (ft)	TOS Elev. (ft)	BOS Elev. (ft)	Grnd. Surf. Elev. (ft)	TOC Elev.	DTW (ft TOC) 2/21/07	GW Elev. (ft) 2/21/07	GW Above Screen (ft) 2/21/07	Alt. Date Meas.	DTW (ft TOC)	GW Elev. (ft)	GW Above Screen (ft)
A19TP6	620848.30	557311.40	3.0-13.0	10.0	10.59	0.59	13.59	13.22	5.57	7.65	N/A	N/A	N/A	N/A	N/A
A19TP7	620953.00	557475.00	3.0-13.0	10.0	10.32	0.32	13.32	12.77	5.62	7.15	N/A	N/A	N/A	N/A	N/A
A8TP23	620719.93	557930.07	2.0-12.0	10.0	10.79	0.79	12.79	12.49	5.48	7.01	N/A	N/A	N/A	N/A	N/A
A8TP24	620726.54	557741.51	3.0-13.0	10.0	9.77	-0.23	12.77	12.42	4.05	8.37	N/A	N/A	N/A	N/A	N/A
A8TP25	620965.96	557535.92	3.0-13.10	10.0	10.24	0.24	13.24	12.92	6.10	6.82	N/A	N/A	N/A	N/A	N/A
A8TP26	621252.80	557448.75	1.0-16.0	15.0	11.93	-3.07	12.93	12.59	N/A	N/A	N/A	03/05/06	5.38	7.21	N/A
EY4TP48	619890.00	560436.00	1.0-11.0	10.0	8.74	-1.26	9.74	9.45	3.56	5.89	N/A	N/A	N/A	N/A	N/A
EY4TP49	619816.10	560449.50	1.0-11.0	10.0	9.06	-0.94	10.06	9.49	4.57	4.92	N/A	N/A	N/A	N/A	N/A
M51TP27	619800.22	558666.30	1.0-11.0	10.0	11.90	1.90	12.9	12.46	2.91	9.55	N/A	N/A	N/A	N/A	N/A
M51TP28	619764.60	558843.20	1.0-11.0	10.0	16.35	6.35	17.35	17.09	5.11	11.98	N/A	N/A	N/A	N/A	N/A
MW-0024	620979.14	557969.89	3.0-13.0	10.0	8.00	-2.00	11.00	13.33	6.92	6.41	N/A	N/A	N/A	N/A	N/A
MW-0029	622632.50	556966.70	3.8-13.8	10.0	7.80	-2.20	11.60	13.96	5.49	8.47	0.67	02/23/04	6.30	7.66	N/A
MW-0030	622238.30	557522.20	2.0-7.0	5.0	4.70	-0.30	6.70	8.57	4.92	3.65	N/A	N/A	N/A	N/A	N/A
MW-0033	621760.10	557935.00	1.0-11.0	10.0	8.70	-1.30	9.70	12.34	9.40	2.94	N/A	N/A	N/A	N/A	N/A
MW-0034	621554.40	557994.00	3.0-8.0	5.0	4.90	-0.10	7.90	10.30	8.15	2.15	N/A	N/A	N/A	N/A	N/A
MW-0037	620318.88	556610.13	5.5-15.5	10.0	22.39	12.39	27.89	30.13	9.86	20.27	N/A	N/A	N/A	N/A	N/A
MW-0051	619778.70	558677.70	1.0-11.0	10.0	12.12	2.12	13.12	12.51	2.72	9.79	N/A	N/A	N/A	N/A	N/A
MW-0054	620292.17	556642.82	4.0-14.0	10.0	22.80	12.80	26.80	29.27	8.53	20.74	N/A	N/A	N/A	N/A	N/A
MW-0055	620247.73	556651.60	4.0-14.0	10.0	23.70	13.70	27.70	30.34	10.40	19.94	N/A	N/A	N/A	N/A	N/A
MW-0056	620207.33	556663.93	4.0-14.0	10.0	23.90	13.90	27.90	30.54	10.01	20.53	N/A	N/A	N/A	N/A	N/A
MW-0057	622647.48	556737.38	1.0-16.0	15.0	14.24	-0.76	15.24	17.64	9.03	8.61	N/A	N/A	N/A	N/A	N/A
MW-0058	622636.65	556928.63	1.0-16.0	15.0	11.03	-3.97	12.03	14.39	4.51	9.88	N/A	N/A	N/A	N/A	N/A
MW-0059	622613.92	556996.15	1.0-14.0	13.0	11.20	-1.80	12.20	15.00	6.02	8.98	N/A	N/A	N/A	N/A	N/A
MW-0060	622584.94	557001.24	2.0-12.0	10.0	9.95	-0.05	11.95	14.43	4.71	9.72	N/A	N/A	N/A	N/A	N/A
MW-0061	622531.75	557013.13	1.0-11.0	10.0	10.83	0.83	11.83	14.28	3.78	10.50	N/A	N/A	N/A	N/A	N/A
MW-0062	622471.66	557022.04	1.0-11.0	10.0	10.32	0.32	11.32	13.67	4.29	9.38	N/A	N/A	N/A	N/A	N/A
MW-0063	622427.96	557031.87	1.0-11.0	10.0	10.40	0.40	11.40	13.80	4.71	9.09	N/A	N/A	N/A	N/A	N/A
MW-0064	622365.25	557061.22	1.0-11.0	10.0	9.36	-0.64	10.36	12.79	5.08	7.71	N/A	N/A	N/A	N/A	N/A
MW-0065	622370.18	557094.84	1.0-11.0	10.0	9.68	-0.32	10.68	13.24	6.32	6.92	N/A	N/A	N/A	N/A	N/A
MW-0066	622358.04	557118.31	1.0-11.0	10.0	9.90	-0.10	10.90	13.25	6.32	6.93	N/A	N/A	N/A	N/A	N/A
MW-0067	622400.77	557056.18	1.0-11.0	10.0	9.90	-0.10	10.90	13.28	4.45	8.83	N/A	N/A	N/A	N/A	N/A
MW-0070	622347.83	557281.37	1.0-11.0	10.0	8.40	-1.60	9.40	11.76	6.06	5.70	N/A	N/A	N/A	N/A	N/A
MW-0071	621518.23	557673.90	1.0-11.0	10.0	5.22	-4.78	6.22	8.18	4.03	4.15	N/A	N/A	N/A	N/A	N/A

Table 41. LNAPL Monitoring Wells and Piezometers

Well ID	Northing	Easting	Screen Int. (ft. bgs)	Screen Length (ft)	TOS Elev. (ft)	BOS Elev. (ft)	Grnd. Surf. Elev. (ft)	TOC Elev.	DTW (ft TOC) 2/21/07	GW Elev. (ft) 2/21/07	GW Above Screen (ft) 2/21/07	Alt. Date Meas.	DTW (ft TOC)	GW Elev. (ft)	GW Above Screen (ft)
MW-0072	622044.90	557091.30	1.0-11.0	10.0	5.70	-4.30	6.70	9.43	4.33	5.10	N/A	N/A	N/A	N/A	N/A
MW-0073	619913.40	558755.60	1.0-11.0	10.0	12.86	2.86	13.86	13.43	4.31	9.12	N/A	N/A	N/A	N/A	N/A
MW-116	622386.10	556277.90	2.0-12.0	10.0	7.70	-2.30	9.70	12.74	5.88	6.86	N/A	N/A	N/A	N/A	N/A
MW-122	622073.70	557269.80	2.5-12.5	10.0	5.75	-4.25	8.25	8.25	4.01	4.24	N/A	N/A	N/A	N/A	N/A
MW-124	621854.40	557882.70	1.5-11.5	10.0	6.60	-3.40	8.10	10.8	4.37	6.43	N/A	N/A	N/A	N/A	N/A
MW-125	621613.70	557849.40	1.5-11.5	10.0	5.60	-4.40	7.10	10.65	6.08	4.57	N/A	N/A	N/A	N/A	N/A
MW-126	621617.80	557976.30	2.0-12.0	10.0	6.20	-3.80	8.20	10.74	7.28	3.46	N/A	N/A	N/A	N/A	N/A
MW-127	621474.40	558011.10	2.0-12.0	10.0	5.80	-4.20	7.80	10.62	6.85	3.77	N/A	N/A	N/A	N/A	N/A
MW-128	621054.10	557555.00	2.0-12.0	10.0	11.00	1.00	13.00	15.90	8.37	7.53	N/A	N/A	N/A	N/A	N/A
MW-131	620148.80	558823.10	2.0-12.0	10.0	11.80	1.80	13.80	16.53	6.58	9.95	N/A	N/A	N/A	N/A	N/A
MW-132	620617.00	560156.00	3.0-15.0	12.0	6.09	-5.91	9.09	9.09	5.32	3.77	N/A	N/A	N/A	N/A	N/A
MW-133	620809.20	557413.20	4.0-14.0	10.0	8.36	-1.64	12.36	12.36	N/A	N/A	N/A	02/13/07	4.68	7.68	N/A
MW-134	620775.40	558140.50	1.5-11.5	10.0	13.05	3.05	14.55	14.55	7.31	7.24	N/A	N/A	N/A	N/A	N/A
MW-136	622177.50	557604.70	1.0-11.0	10.0	7.70	-2.30	8.70	8.11	4.04	4.07	N/A	N/A	N/A	N/A	N/A
MW-144	619947.30	560284.60	4.0-14.0	10.0	6.12	-3.88	10.12	10.12	N/A	N/A	N/A	10/12/06	4.76	5.36	N/A
MW-147	620033.30	556564.30	4.0-14.0	10.0	24.50	14.50	28.50	30.87	7.94	22.93	N/A	N/A	N/A	N/A	N/A
MW-149	619744.50	560327.40	3.0-13.0	10.0	7.31	-2.69	10.31	10.31	6.68	3.63	N/A	N/A	N/A	N/A	N/A
MW-151	619166.10	560359.30	2.5-12.5	10.0	6.50	-3.50	9.00	11.58	7.67	3.91	N/A	N/A	N/A	N/A	N/A
MW-152	620017.20	558707.60	2.5-12.5	10.0	10.20	0.20	12.70	15.40	6.02	9.38	N/A	N/A	N/A	N/A	N/A
MW-155	619355.90	560674.80	2.5-9.0	6.5	4.30	-2.20	6.80	9.72	6.86	2.86	N/A	N/A	N/A	N/A	N/A
MW-156	619314.20	560674.80	1.75-8.75	7.0	4.95	-2.05	6.70	10.15	7.34	2.81	N/A	N/A	N/A	N/A	N/A
MW-157	619737.20	559450.80	2.0-8.0	6.0	16.00	10.00	18.00	21.07	7.00	14.07	N/A	N/A	N/A	N/A	N/A
MW-190	620504.42	556564.46	3.0-13.0	10.0	15.80	5.80	18.80	21.35	9.87	11.48	N/A	N/A	N/A	N/A	N/A
MW-208	620029.20	558793.80	2.5-9.5	7.0	10.90	3.90	13.40	15.57	5.43	10.14	N/A	N/A	N/A	N/A	N/A
MW-211	622502.20	556298.00	1.0-8.0	7.0	7.30	0.30	8.30	10.70	4.98	5.72	N/A	N/A	N/A	N/A	N/A
MW-213	620606.70	560078.70	3.0-13.0	10.0	8.35	-1.65	11.35	10.77	6.93	3.84	N/A	N/A	N/A	N/A	N/A
MW-214	620603.20	560158.30	3.0-13.0	10.0	6.54	-3.46	9.54	9.11	5.26	3.85	N/A	N/A	N/A	N/A	N/A
MW-215	620647.30	560152.20	3.0-13.0	10.0	4.10	-5.90	7.10	9.79	6.02	3.77	N/A	N/A	N/A	N/A	N/A
MW-233	622290.10	556232.00	1.0-6.0	5.0	7.70	2.70	8.70	11.63	4.56	7.07	N/A	N/A	N/A	N/A	N/A
MW-234	622342.70	556388.00	2.0-8.0	6.0	4.40	-1.60	8.80	11.21	4.20	7.01	2.61	N/A	N/A	N/A	N/A
MW-243	621528.40	557874.90	2.5-8.5	6.0	6.81	0.81	9.31	9.08	4.46	4.62	N/A	N/A	N/A	N/A	N/A
MW-253	620017.70	560326.30	4.5-9.5	5.0	5.64	0.64	10.14	9.75	7.55	2.20	N/A	N/A	N/A	N/A	N/A
MW-254	619755.50	560371.30	5.0-10.0	5.0	4.73	-0.27	9.73	9.39	5.93	3.46	N/A	N/A	N/A	N/A	N/A

Table 41. LNAPL Monitoring Wells and Piezometers

Well ID	Northing	Easting	Screen Int. (ft. bgs)	Screen Length (ft)	TOS Elev. (ft)	BOS Elev. (ft)	Grnd. Surf. Elev. (ft)	TOC Elev.	DTW (ft TOC) 2/21/07	GW Elev. (ft) 2/21/07	GW Above Screen (ft) 2/21/07	Alt. Date Meas.	DTW (ft TOC)	GW Elev. (ft)	GW Above Screen (ft)
MW-256	619210.00	560481.30	5.0-10.0	5.0	3.70	-1.30	8.70	11.09	7.41	3.68	N/A	N/A	N/A	N/A	N/A
NF 11	622449.60	556507.68	2.5-12.5	10.0	6.19	-3.81	8.69	10.81	3.96	6.85	0.66	09/27/05	4.41	6.40	0.21
PZ-12	620848.58	557354.29	1.0-11.0	10.0	12.96	2.96	13.96	15.67	9.54	6.13	N/A	N/A	N/A	N/A	N/A
RW-1	622333.00	556159.50	3.0-13.0	10.0	9.70	-0.30	12.70	15.20	N/A	N/A	N/A	09/21/06	7.39	7.81	N/A
RW-11	622242.20	556144.50	1.0-11.0	10.0	6.70	-3.30	7.70	9.76	5.31	4.45	N/A	N/A	N/A	N/A	N/A
RW-2	622175.90	557543.50	3.0-13.0	10.0	10.80	0.80	13.80	13.28	6.21	7.07	N/A	N/A	N/A	N/A	N/A
RW-21	621990.20	557000.10	1.0-11.0	10.0	6.80	-3.20	7.80	10.32	5.81	4.51	N/A	N/A	N/A	N/A	N/A
RW-31	621328.70	557819.50	2.0-12.0	10.0	6.10	-3.90	8.10	11.12	5.04	6.08	N/A	N/A	N/A	N/A	N/A
RW-32	621428.30	557849.30	1.0-11.0	10.0	8.40	-1.60	9.40	12.16	6.79	5.37	N/A	N/A	N/A	N/A	N/A
RW-33	621447.10	557875.50	2.0-12.0	10.0	7.25	-2.75	9.25	8.85	6.24	2.61	N/A	N/A	N/A	N/A	N/A
RW-34	621380.70	557894.10	1.0-10.0	9.0	7.39	-1.61	8.39	8.00	5.09	2.91	N/A	N/A	N/A	N/A	N/A
RW-35	621447.00	557724.00	1.0-8.0	7.0	5.70	-1.30	6.70	9.22	3.16	6.06	0.36	10/19/06	4.24	4.98	N/A
RW-41	621220.00	557768.00	1.0-11.0	10.0	7.17	-2.83	8.17	7.84	1.42	6.42	N/A	N/A	N/A	N/A	N/A
RW-42	621216.50	557663.20	1.0-10.0	9.0	11.10	2.10	12.10	15.13	8.56	6.57	N/A	N/A	N/A	N/A	N/A
RW-61	619860.20	558816.90	1.0-9.0	8.0	12.90	4.90	13.90	16.40	6.09	10.31	N/A	N/A	N/A	N/A	N/A
RW-81	619650.70	560196.90	2.0-12.0	10.0	11.30	1.30	13.30	15.95	8.91	7.04	N/A	N/A	N/A	N/A	N/A
RW-82	619700.00	560148.80	1.0-11.0	10.0	12.40	2.40	13.40	16.57	8.72	7.85	N/A	N/A	N/A	N/A	N/A
RW-83	619799.60	560224.80	1.0-11.0	10.0	10.00	0.00	11.00	13.51	9.11	4.40	N/A	N/A	N/A	N/A	N/A
RW-91	619312.70	560225.50	1.5-11.5	10.0	9.27	-0.73	10.77	10.43	3.47	6.96	N/A	N/A	N/A	N/A	N/A
RW-92	619346.80	560289.00	1.5-10.0	8.5	9.60	1.10	11.10	14.15	8.33	5.82	N/A	N/A	N/A	N/A	N/A
RW-93	619357.80	560370.90	1.5-11.5	10.0	7.80	-2.20	9.30	11.70	6.58	5.12	N/A	N/A	N/A	N/A	N/A
RW-94	619324.10	560481.00	1.5-11.0	9.5	7.02	-2.48	8.52	8.12	4.51	3.61	N/A	N/A	N/A	N/A	N/A
S40TP1	621670.80	557899.10	2.0-12.0	10.0	7.35	-2.65	9.35	8.99	2.92	6.07	N/A	N/A	N/A	N/A	N/A
S43TP9	622581.30	556769.70	5.0-15.0	10.0	8.32	-1.68	13.32	12.9	5.81	7.09	N/A	N/A	N/A	N/A	N/A
SB 15	619020.04	556546.21	2.0-12.0	10.0	3.98	-6.02	5.98	8.74	5.09	3.65	N/A	N/A	N/A	N/A	N/A

TOS = Top of Screen

TOC = Top of Casing

DTW = Depth to Water

GW = Groundwater

BOS = Bottom of Screen

N/A = Not Applicable

6.43 Comment 43**RFI Section: 7, page 133, #6, bullet 3****Comment Letter Page: 7**

Chevron indicates that many of the lenses and layers of material which contain LNAPL are found below the water table. In addition, there is a tidal influence on ground water. The Department is concerned that there may be a tidal influence on LNAPL thickness measurements. Therefore, for each AOC at which there is a tidal influence on ground water elevation and LNAPL has been found or is suspected, Chevron shall perform a tidal study in representative monitor wells. Chevron shall collect depth to top of LNAPL and depth to the ground water LNAPL interface data during both high and low tide. Chevron shall determine if there is a relationship between LNAPL thickness and tidal stage.

Chevron Response

Chevron acknowledges the Department's concerns and has performed a detailed evaluation of tidal influences at monitoring wells in the vicinity of SWMU 40, SWMU 41, and AOC8-NF6. Two tidal studies were completed as part of the evaluation of tidal influence along Woodbridge Creek.

Short-Term Tidal Study

The initial tidal study was a short-term study conducted over the period of one tide cycle on June 16, 2005. The objective of this study was to evaluate the effect of daily tides on the water elevation and LNAPL thicknesses (if present) in monitoring wells near the Creek. The study area included 13 monitoring wells located in the vicinity of SWMU 40, SWMU 41, and AOC8-NF6 LNAPL areas (Figure 41). The well identifications and their construction details are listed in Table 42. The 13 wells are screened across the groundwater table. In general, the wells included in the study are within 10 feet (9 wells) to 100 feet (4 wells) of the Woodbridge Creek. Wells were chosen based on historical observations, where two of the 13 wells have contained LNAPL. These two wells (MW-0033 and RW-11) occasionally contain residual amounts of LNAPL.

Tidal Study Procedure

The tidal study involved collection of groundwater level data (and LNAPL thickness data), utilizing an electronic oil/water interface probe, from the designated wells for a full 8-hour period; thereby capturing both high and low tide cycles. The tidal study also included the utilization of a daily tide data prediction table to better define the starting time of the study and compare the tidal effect of the wells with respect to the tidal elevation of the Woodbridge Creek.

Table 42. Tidal Study Monitoring Well Construction Details

Well ID	Yard	TOS (ft. bgs)	BOS (ft. bgs)	Elev. TOS (ft. msl)	Elev. BOS (ft. msl)	Elev. Ground Surface (ft. msl)	MPE (ft msl)
MW-0030	NF	2.00	7.00	4.70	-0.30	6.70	8.57
MW-0031	NF	1.50	6.50	3.90	-1.10	5.40	7.45
MW-0032	NF	1.50	6.50	4.50	-0.50	6.00	7.88
MW-0033	NF	1.00	11.00	8.70	-1.30	9.70	12.34
MW-0034	NF	3.00	8.00	4.90	-0.10	7.90	10.30
MW-124	NF	1.50	11.50	6.60	-3.40	8.10	10.80
MW-125	NF	1.50	11.50	5.60	-4.40	7.10	10.65
MW-126	NF	2.00	12.00	6.20	-3.80	8.20	10.74
MW-127	NF	2.00	12.00	5.80	-4.20	7.80	10.62
MW-136	NF	1.00	11.00	7.70	-2.30	8.70	8.11
P-10	MY	23.50	28.50	-15.87	-20.87	7.63	10.25
RW-11	NF	1.00	11.00	6.70	-3.30	7.70	9.76
RW-33	NF	2.00	12.00	7.25	-2.75	9.25	8.85

TOS = Top of Screen

BOX = Bottom of Screen

MPE = Measuring Point Elevation

Tidal Study

A daily tide prediction table, with hourly tide elevations, was not available for the Woodbridge Creek. As a replacement, Chevron obtained the daily tide prediction table for South Amboy – Raritan River, which is located approximately 3.5 miles south of the Woodbridge Creek. Referring to this chart, on June 16, 2005, the low tide was at 09:45 hours, and the high tide was at 15:45 hours. Correction factors for tidal delay between the Woodbridge Creek and the South Amboy gauging stations (12 minutes for high tide and 13 minutes for low tide) were provided by NOAA/NOS CO-OPS. Applying these corrections, the test was conducted from 08:00 to 16:30 hours.

The initial round of water levels from each well indicated groundwater levels between 3.50 feet below measuring point (MW-0031) and 9.00 feet below measuring point (MW-0033). Of the 13 wells, only two contained LNAPL (MW-0033, trace and RW-11, globules). Throughout the study, special attention was given to the amount of LNAPL observed, to determine if there is a tidal effect on the product thickness. Field data were collected every hour following the same sequence of wells. The data collected in the field are presented in Table 43.

Table 43. June 16, 2005 Short-Term Tidal Study Data

Time	MW-30 (ft)	MW-31 (ft)	MW-32 (ft)	MW-33 (ft)	MW-34 (ft)	MW-124 (ft)	MW-125 (ft)	MW-126 (ft)	MW-127 (ft)	MW-136 (ft)	P-10 (ft)	RW-11 (ft)	RW-33 (ft)
8.00	7.50	3.52	3.87	9.00 ^{TR}	7.86	4.65	5.45	8.24	8.04	4.32	4.57	6.82 ^{GL}	3.74
9.00	7.49	3.53	3.88	9.00 ^{TR}	7.94	4.67	5.45	8.27	8.06	4.34	4.61	6.79 ^{GL}	3.74
10.00	7.48	3.53	3.88	9.00 ^{TR}	8.02	4.68	5.45	8.30	8.09	4.34	4.66	6.75 ^{GL}	3.73 [*]
11.00	7.47	3.53	3.87	9.00 ^{TR}	8.07	4.66	5.44	8.33	8.12	4.35	4.67	6.69 ^{GL}	3.74 ^{**}
12.00	7.46	3.51	3.86	9.00 ^{TR}	8.10	4.61	5.42	8.35	8.13	4.36	4.54	6.65 ^{GL}	3.72
13.00	7.45	3.50	3.85	9.00 ^{TR}	8.04	4.58	5.42	8.34	8.11	4.35	4.51	6.61 ^{GL}	3.72
14.00	7.44	3.49	3.84	9.00 ^{TR}	7.86	4.51	5.41	7.68	8.06	4.36	4.37	6.58 ^{GL}	3.73 ^{***}
15.00	7.45	3.44	3.78	8.99 ^{TR}	7.70	4.45	5.40	7.33	8.04	4.35	4.27	6.55 ^{GL}	3.71
16.00	7.45	3.38	3.69	8.96 ^{TR}	7.41	4.40	5.38	6.93	7.95	4.32	4.21	6.50 ^{GL}	3.71

*SAIC Sampling well RW-33, time 10:50 AM

**SAIC Placed multi probe in well RW-33 @ time 11:40; raising water level from 3.74 to 3.72

***SAIC removed multi probe from RW-33 @ time 13:45; lowering water level to 3.73

^{TR}Trace of LNAPL Present^{GL}Globules of LNAPL Present

High Tide: 3:45 PM

Low Tide: 9:45 AM

Tidal Fluctuation: 4 ft

Data Interpretation

Field data were converted to elevation for direct comparison to the tidal fluctuation observed in the Woodbridge Creek (Table 44). These data are presented in Chart 1 below. As summarized in Table 43, the tidal fluctuation in the Woodbridge Creek during the study was approximately 4 feet. In response to this surge, wells displayed a minimal tidal effect. Very slow rates of tidal influence indicate that these wells are screened within a relatively low energy depositional environment, consisting of mostly silts and clays, which do not possess high permeabilities. This conclusion is also supported by boring logs, well purging records, and LNAPL recovery attempts.

As shown on Table 43, the largest tidal influence was observed in wells MW-126 (1.42 feet) and MW-0034 (0.69 feet). The smallest changes were observed in RW-33 (0.03 feet), and MW-0033 (0.04 feet). During the course of the study, the LNAPL thickness observed in RW-11 (SWMU 41) and MW-0033 (SWMU 40) remained the same despite the changing tide levels.

As a result, Chevron concludes that any LNAPL present in the wells is residual in nature and does not get masked by changing groundwater levels. In addition, LNAPL thicknesses in monitoring wells do not fluctuate with changes in tide stage and remained stable during the period of the tide cycle from low tide to high tide.

Long-Term Tidal Study

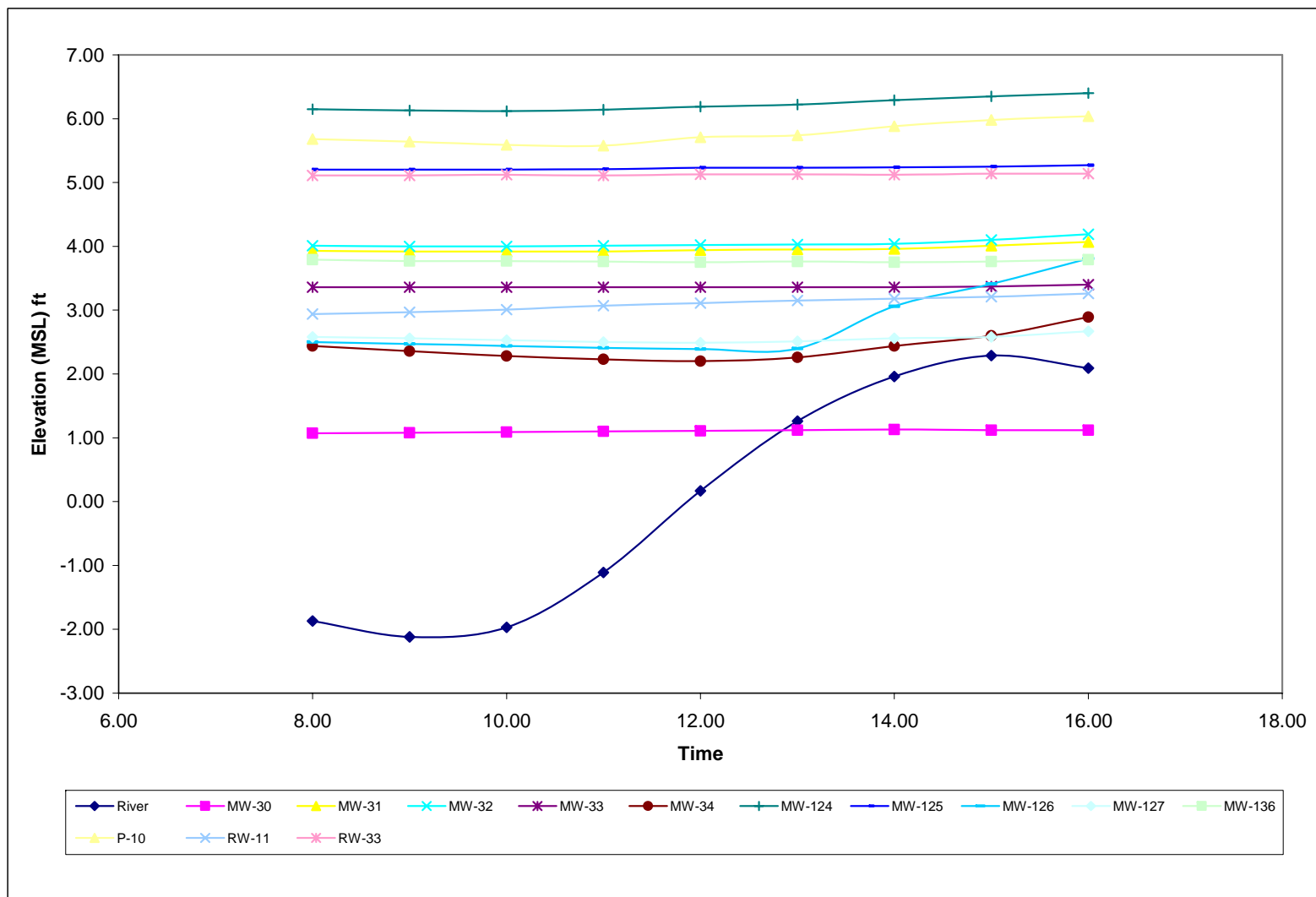
A long-term tidal study was conducted over a period of 15 days from June 9, 2006 through June 23, 2006. The objective of this study was to further evaluate the effects of daily tides on the groundwater levels in monitoring wells near Woodbridge Creek and confirm the results of the initial short term tidal study. The study area included four monitoring wells located in the vicinity of SWMU 40 and SWMU 41, the two LNAPL areas closest to the Woodbridge Creek (Figure 41). MW-0033 and RW-11 were included based on the presence of trace amounts of LNAPL in these wells during the short-term tidal study. MW-136 was included due to the well's proximity to SWMU 41. Finally, MW-126 was included because of the greater than one foot tidal fluctuation observed in this well during the short term study. The four monitoring wells are within 50 feet of the Woodbridge Creek and screened across the water table.

Tidal Study Procedure

The long-term tidal study involved collection of groundwater level data utilizing electronic water level data logging devices. A Level TROLL 700 was placed in each of the four wells on June 9, 2006. Each Level TROLL 700 collected and logged the water level in each well every 5 minutes for a period of 15 days. At the conclusion of the tidal study, the water level data were downloaded from each Level Troll 700 to a laptop computer in the field. The raw water level data from the four wells was graphed and compared to tide elevation data.

Table 44. Comparative Ground Water & Tidal Elevation Data for June 16, 2005

Time	River (ft msl)	MW-30 (ft msl)	MW-31 (ft msl)	MW-32 (ft msl)	MW-33 (ft msl)	MW-34 (ft msl)	MW-124 (ft msl)	MW-125 (ft msl)	MW-126 (ft msl)	MW-127 (ft msl)	MW-136 (ft msl)	P-10 (ft msl)	RW-11 (ft msl)	RW-33 (ft msl)
8.00	-1.87	1.07	3.93	4.01	3.36	2.44	6.15	5.20	2.50	2.58	3.79	5.68	2.94	5.11
9.00	-2.12	1.08	3.92	4.00	3.36	2.36	6.13	5.20	2.47	2.56	3.77	5.64	2.97	5.11
10.00	-1.97	1.09	3.92	4.00	3.36	2.28	6.12	5.20	2.44	2.53	3.77	5.59	3.01	5.12
11.00	-1.11	1.10	3.92	4.01	3.36	2.23	6.14	5.21	2.41	2.50	3.76	5.58	3.07	5.11
12.00	0.17	1.11	3.94	4.02	3.36	2.20	6.19	5.23	2.39	2.49	3.75	5.71	3.11	5.13
13.00	1.26	1.12	3.95	4.03	3.36	2.26	6.22	5.23	2.40	2.51	3.76	5.74	3.15	5.13
14.00	1.96	1.13	3.96	4.04	3.36	2.44	6.29	5.24	3.06	2.56	3.75	5.88	3.18	5.12
15.00	2.29	1.12	4.01	4.10	3.37	2.60	6.35	5.25	3.41	2.58	3.76	5.98	3.21	5.14
16.00	2.09	1.12	4.07	4.19	3.40	2.89	6.40	5.27	3.81	2.67	3.79	6.04	3.26	5.14

**Chart 1. Tidal Study Field Data**

Tidal Study

A daily tide prediction table, with tide elevations, was not available for the Woodbridge Creek. As a replacement, Chevron obtained the daily tide data collected continuously at six minute intervals from the South Amboy – Raritan River tide gauge, which is located approximately 3.5 miles south of the Woodbridge Creek. Correction factors for tidal delay between the Woodbridge Creek and South Amboy gauging stations (12 minutes for high tide and 13 minutes for low tide) were provided by NOAA/NOS CO-OPS. Tide data were graphed and compared to graphs of water level data collected from each monitoring well.

During the course of the tidal study, more than 4,300 water level measurements were collected from each of the four monitoring wells. Due to the large quantity of data, a representative set of data from a four day period from June 19 through June 23, 2006 is presented in this evaluation. During this four day period, groundwater levels in monitoring wells MW-0033, MW-136, and RW-11 generally fluctuated less than 0.1 feet between the highest high tides and lowest low tides occurring during the evaluation (Chart 2, Chart 3, and Chart 4, respectively). Groundwater levels in MW-126 exhibited fluctuations up to 1.5 feet between high tide and low tide (Chart 5).

Data Interpretation

During the course of the tidal study, MW-0033, MW-136, and RW-11 displayed minimal tidal effect (less than 0.1 feet). Boring logs for these wells indicate the wells are screened in low permeability soils such as silts and clays. The minor tidal fluctuation in these wells is likely the result of the soils in which the wells are screened. Based on the boring log, groundwater in MW-126 is found within a lens of sandy fill materials containing catalyst beads. These materials have a higher permeability than the soils associated with monitoring wells MW-0033, MW-136, and RW-11. The larger tidal fluctuations in MW-126 are attributable to the higher permeability soils in which MW-126 is screened. Boring logs for the MW-0033, MW-126, MW-136, and RW-11 are included in Appendix A.

The results of the long-term tidal study confirm the results of the short-term tidal study and indicate that monitoring wells in SWMU 40 (MW-0033) and SWMU 41 (MW-136 and RW-11) along the Woodbridge Creek generally show only minor tidal fluctuations. The greatest fluctuations are observed in MW-126 which is not located within an LNAPL area. These findings are consistent with the findings from the short-term study.

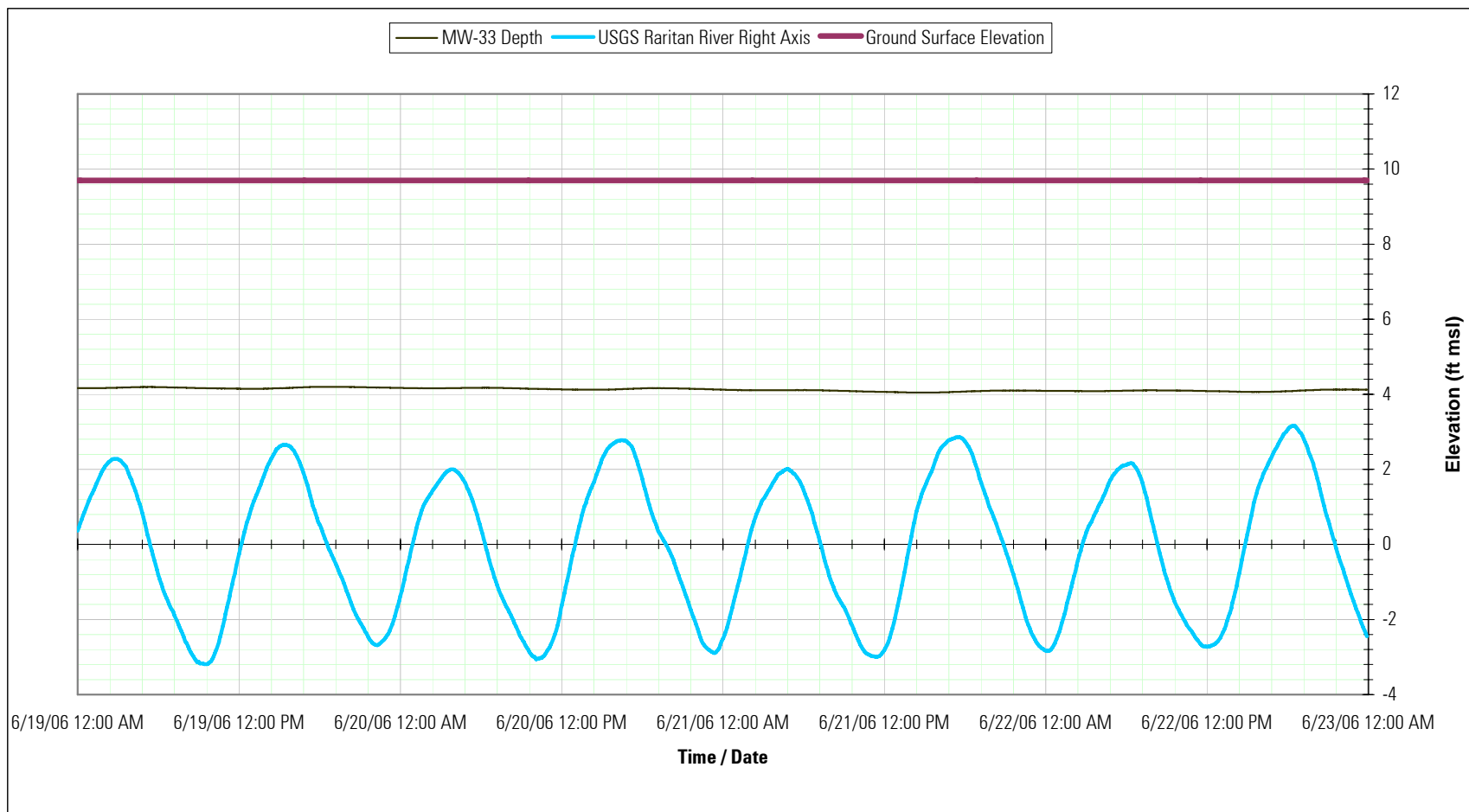


Chart 2. Tidal Fluctuation at MW-0033

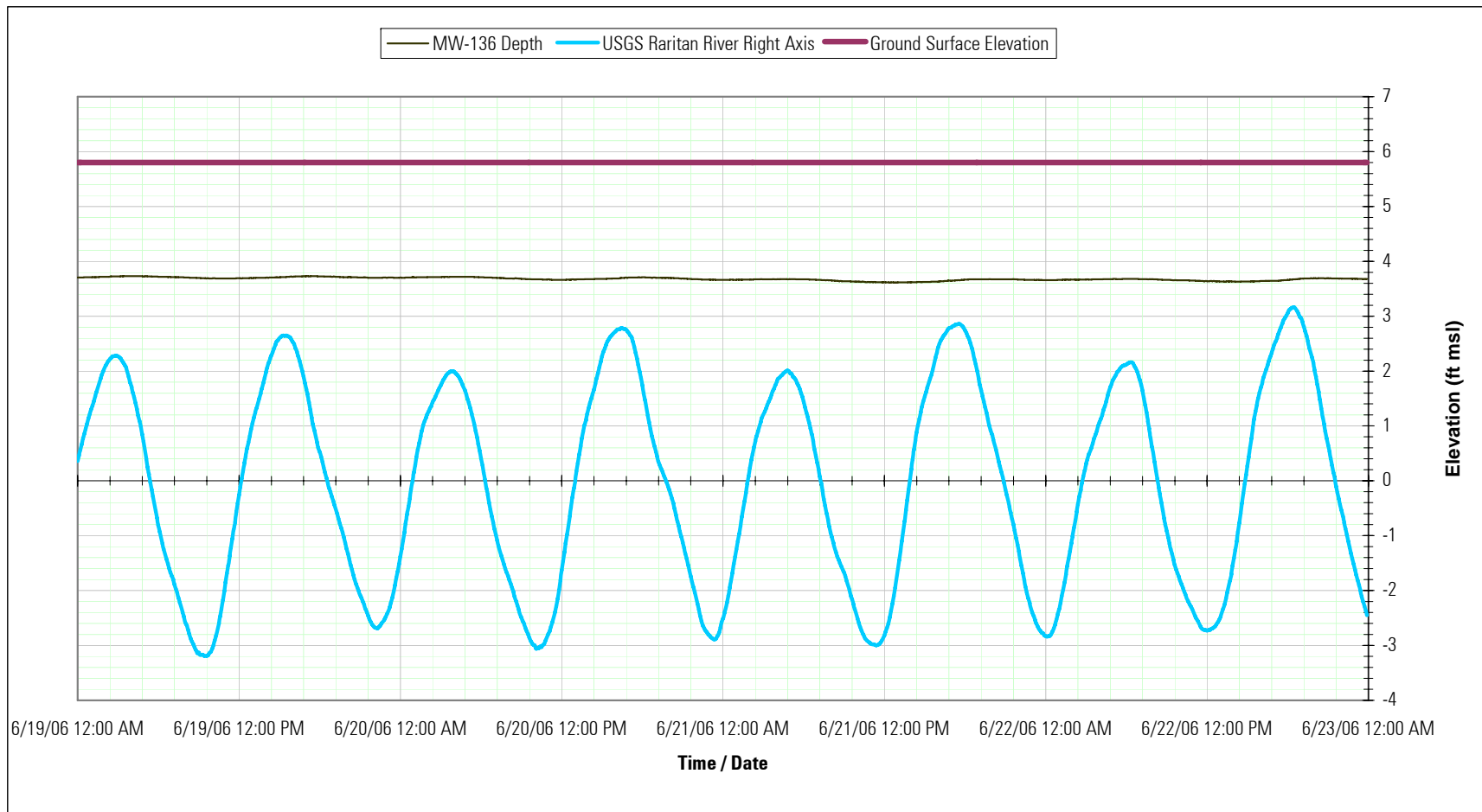


Chart 3. Tidal Fluctuation at MW-136

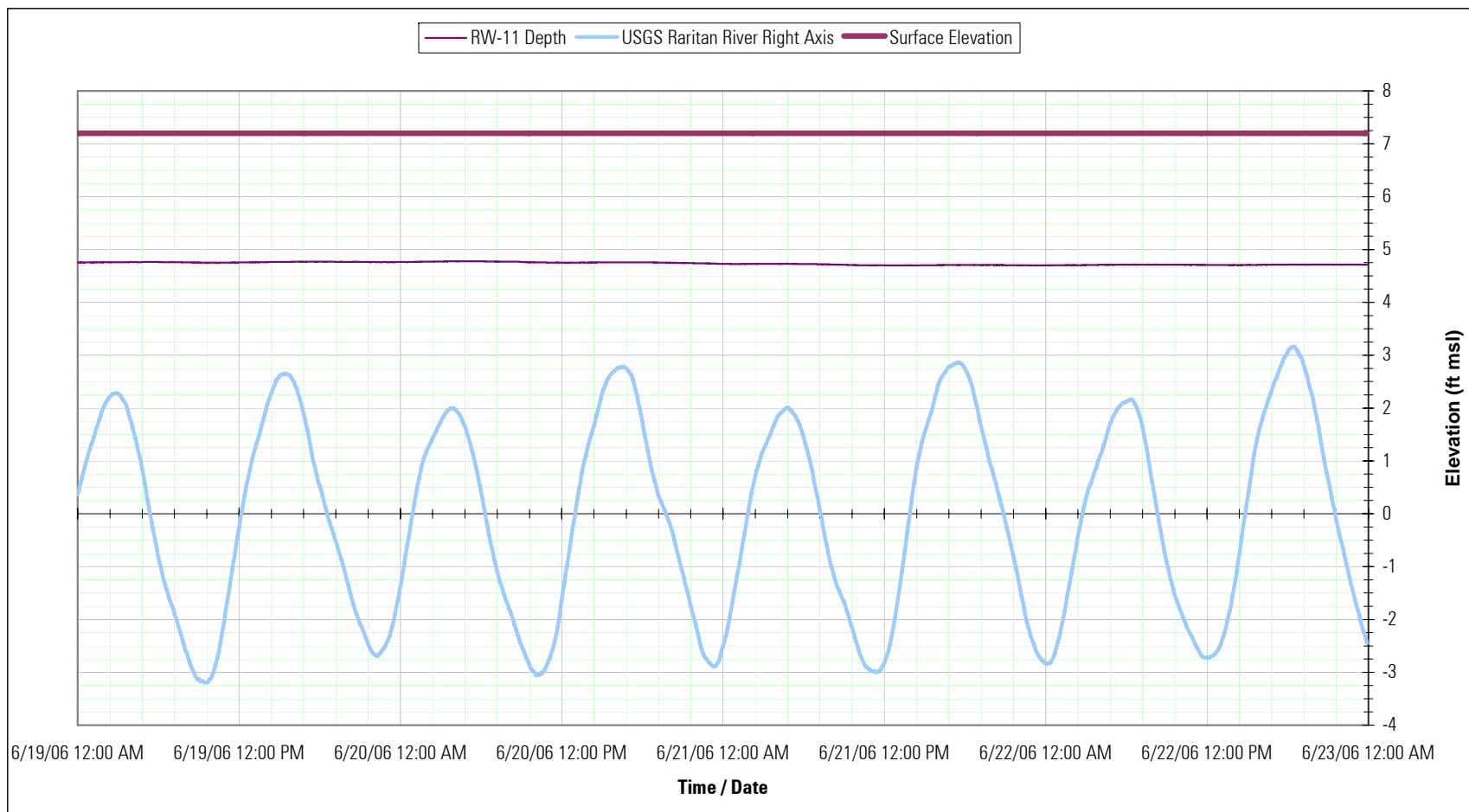


Chart 4. Tidal Fluctuation at RW-11

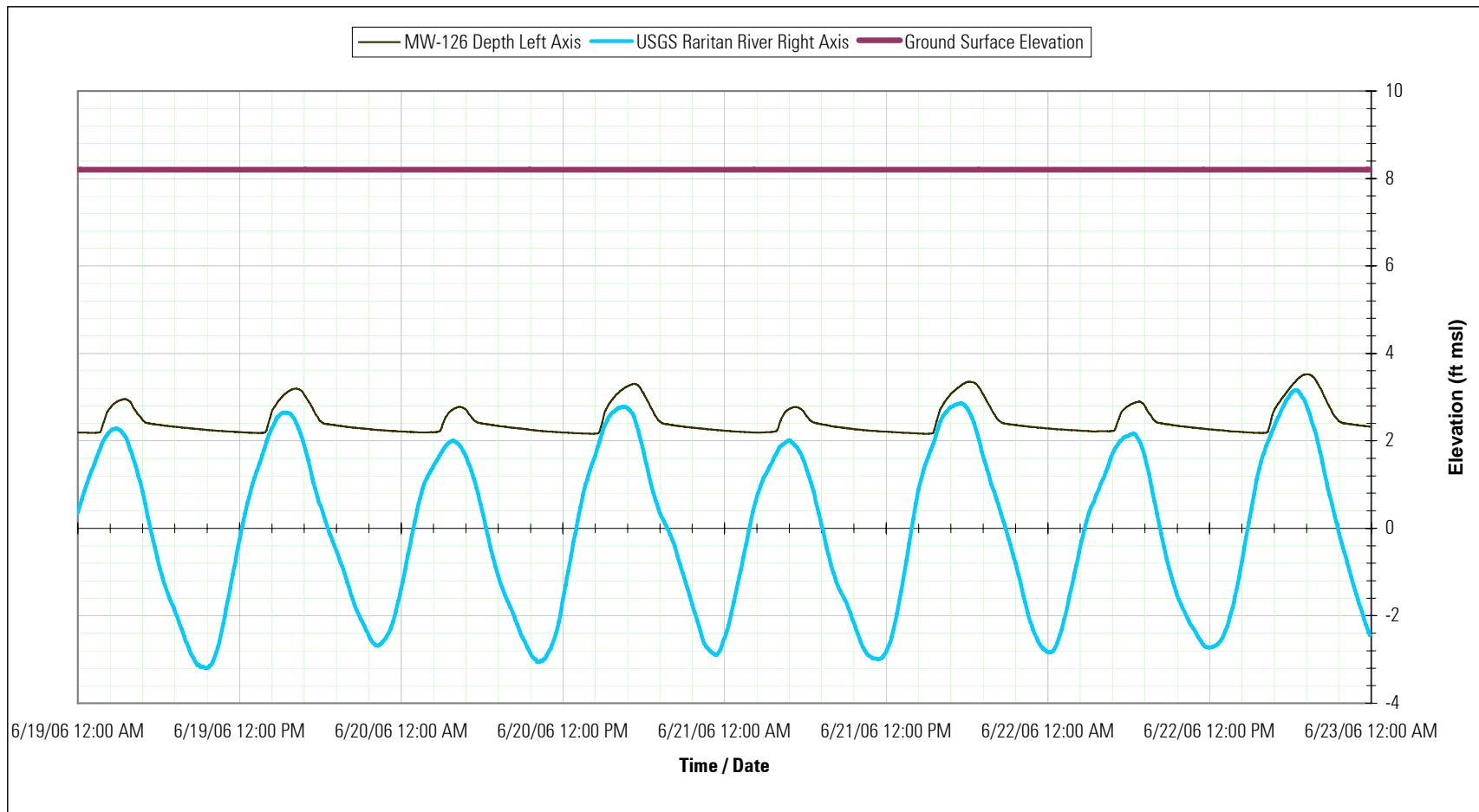


Chart 5. Tidal Fluctuation at MW-126

6.44 Comment 44**RFI Section: 7.1****Comment Letter Page: 7**

Chevron has not included an evaluation of the effect of subsurface piping on LNAPL migration. Therefore, using the data gathered to date, Chevron shall determine if subsurface utilities/piping are controlling LNAPL migration. Chevron shall submit a report detailing this evaluation. The report shall include recommendations for additional investigation where appropriate.

Chevron Response

As described in the response to Comment 41 above, Chevron believes the OWSS, the primary underground piping system at the Refinery, has been adequately investigated during the Phase I and Phase II OWSS investigation. Impacts identified during the OWSS investigation were thoroughly delineated as part of the subsequent LNAPL Management Program and Full RFI. Therefore, no additional evaluation or investigation of the subsurface piping/utilities is warranted.

6.45 Comment 45**RFI Section: 7.1.4, page 135, #5****Comment Letter Page: 7**

Chevron indicates that the extent of LNAPL has been defined using piezometers and permanent wells. According to figure 7-2, the most downgradient permanent monitor well (MW-33) contained LNAPL. Therefore, Chevron shall propose to install additional permanent monitor wells downgradient from MW-33 and HP-0001-P. The purpose of these wells will be to monitor for the presence of NAPL and to monitor ground water quality. While a boring program was completed along Woodbridge Creek and no NAPL was detected, there is a need to regularly monitor ground water quality as it discharges to the Woodbridge Creek located close to this AOC.

Chevron Response

Extensive investigations and recovery efforts have confirmed that the LNAPL at SWMU 40 (Old Pond) is residual and adsorbed to soil particles. Chevron is performing weekly monitoring at MW-0033 which has shown that the LNAPL detections are infrequent and only detected as globules on an interface probe. Since 1999, total liquids from MW-0033 have been evacuated on a weekly basis. The hydrograph in Appendix H depicts liquid levels and LNAPL detections observed at MW-0033 from 2002 through 2006. Additional information for the SWMU 40 LNAPL Area and MW-0033 was provided in the 2005 Stabilization Measures Status Report submitted to the NJDEP in January 2007.

Chevron agrees with the NJDEP that groundwater quality needs to be monitored. Accordingly, Chevron has resumed semi-annual groundwater sampling at MW-0033 for VOCs and SVOCs. Results from eight rounds of sampling between 2003 and 2006 have shown no exceedances of the SRFI Evaluation Criteria for VOCs. Chrysene was the only SVOC to exceed the SRFI Evaluation Criteria at MW-0033, (17J µg/L) in one of the eight samples collected on June 10, 2005. However, Chevron believes this exceedance is anomalous and is not indicative of groundwater quality at MW-0033 because no SVOC exceedances were noted in the three subsequent samples collected between November 2005 and November 2006, or in the four samples collected prior to June 10, 2005. The groundwater results obtained from MW-0033 between 2003 and 2006 are provided in Appendix G.

In addition to Chevron's groundwater monitoring program, a MIP survey was conducted during the SRFI in 2006 to optimize the location of additional monitoring wells along the Woodbridge Creek in the NF (see Sections 4.3 and 5.5). This survey consisted of 10 MIP points. Four of these MIP points (S2092, S2097, S2098, and S2099) were located downgradient of SWMU 40. The MIP surveys ranged in depth from 22.0 to 29.0 ft. bgs and did not indicate the presence of VOCs. These findings indicated that the existing monitoring well network is sufficient to monitor this portion of the site and that no additional monitoring wells need to be installed.

SWMU 40 is currently being evaluated as part of the CMS to determine applicable remedial measures. The CMS Report will be submitted to EPA and NJDEP in 2008.

6.46 Comment 46**RFI Section: 7.1.4, page 137, #3****Comment Letter Page: 7**

Chevron indicates that the lateral delineation of LNAPL at SWMU 40 was completed with NFTP2, MW-124, MW-125 and MW-126. The distance between LNAPL delineation points at SWMU 40 is large considering that LNAPL is found in discontinuous pockets and lenses. The spacing of the sampling grid should match the expected size of the LNAPL pockets. For example, according to Figure 7-2, it can be determined that LNAPL ends somewhere between HP-0001-P and monitor well MW-126, a distance of approximately ninety feet. In order to evaluate potential corrective measures at this SWMU, it will be necessary to have a better grasp on the lateral extent of the contamination and the location of additional pockets of LNAPL.

Chevron Response

As discussed in Comment 22, SRFI borings S2092, S2097, S2098, and S2099 address the delineation of contaminants at SWMU 40 adjacent to the Woodbridge Creek. Borings S2092, S2098, and S2099 are MIP borings. Delineation data from these borings is provided in Section 5.5. Boring S2097 is also a MIP boring that was additionally sampled for TCL VOC's +10 and TAL Metals. Samples collected from this boring did not exceed the NJDEP NRDSCC for VOCs. One sample, S2097G1 (12.0 to 12.5 ft. bgs.) contained 25.7 mg/kg, marginally exceeding the NJDEP NRDCSCC for arsenic (20 mg/kg). Further discussion of arsenic in the NF/MY can be found in Section 5.1 and is depicted on Figure 6.

6.47 Comment 47**RFI Section: 7.1.4, page 138, last #****Comment Letter Page: 8**

Chevron indicates that the lack of VOCs above the groundwater criteria suggest that the NAPL does not pose a threat to groundwater or any nearby sensitive receptors. The Department notes that semi-volatile organic compounds have been detected in H0840. These compounds may have an impact on the Woodbridge Creek. This potential needs additional evaluation. Chevron shall propose to collect sediment samples from the Woodbridge Creek at a location downgradient from SWMU 40.

Chevron Response

Elevated PAH concentrations were detected in H0840 collected from a temporary well located approximately 10 feet from monitoring well MW-0033. However, there were no VOC or SVOC exceedances in seven groundwater samples subsequently collected from permanent well MW-0033 between 2003 and 2006. The PAH concentrations in H0840 are attributable to the adsorption of these compounds to fine particles suspended in the sample. Based on subsequent sample results, these concentrations are not representative of groundwater quality at SWMU 40. Based on the groundwater results from MW-0033, Chevron does not believe sediment samples downgradient of SWMU 40 are warranted. The groundwater results obtained from MW-0033 are provided in Appendix G.

6.48 Comment 48**RFI Section: 7.2, page 143, #4****Comment Letter Page: 8**

Chevron indicates that the LNAPL area at SWMU 41 does not pose a threat to Woodbridge Creek. Chevron shall install a permanent monitor well at the location of H0903 and include this well in the monitoring program to confirm dissolved constituents are not migrating to the Woodbridge Creek.

Chevron Response

Temporary well point H0903 was installed at a location 45 feet east, south and north of RW-11, MW-0030, and MW-136, respectively. Since LNAPL is no longer present in RW-11 as depicted on the hydrograph in Appendix H, Chevron has included RW-11 in its semi-annual groundwater monitoring program for VOCs and SVOCs. Four rounds of groundwater samples were obtained from RW-11 between June 2005 and November 2006. Results from these samples reveal no dissolved phase constituents above the SRFI Evaluation Criteria in three of the four samples. Benzene was detected at a concentration of 6 µg/L in one sample obtained on November 16, 2005. However, no exceedances were noted in two subsequent samples collected in 2006. In addition, during the recent SRFI activities, Chevron installed a deep well (MW-237) screened from 22.0 to 27.0 ft. bgs adjacent to MW-136. A total of 20 groundwater samples collected between November 2002 and November 2006 from MW-0030, MW-136, and MW-237 revealed no exceedances of the SRFI Evaluation Criteria for VOCs and SVOCs.

Chevron believes the elevated PAH concentrations detected at H0903 are attributable to the adsorption of these compounds to fine particles suspended in the sample. Based on the groundwater results from RW-11, MW-0030, MW-236, and MW-237, an additional monitoring well is not necessary at H0903. Chevron proposes to continue dissolved phase monitoring at RW-11, MW-0030, MW-136, and MW-237.

6.49 Comment 49

RFI Section: 7.3, page 149, last #
Comment Letter Page: 8

Chevron indicates that the LNAPL at SWMU 43 does not extend beyond the decontamination pad. Additional delineation is required in this area beneath the pad. Chevron shall complete delineation after the decontamination pad is removed.

Chevron Response

Chevron acknowledges the Department's comment. Additional information will be provided in the CMS Report.

6.50 Comment 50**RFI Section: 7.4, page 162, #6****Comment Letter Page: 8**

Chevron indicates that "no indications have been found that would suggest AOC8-NF6 is receiving LNAPL from ongoing or upgradient sources". Chevron shall detail the potential sources (tanks, crude unit etc.) of the NAPL found in this area. Chevron shall indicate if any of the potential sources are currently in use. This information is required to confirm that there are no potential ongoing sources of NAPL in the area.

Chevron Response

Based on extensive monitoring within the AOC8-NF6 LNAPL Area, Chevron reasserts its position that there are no ongoing sources. LNAPL within this area has resulted from former Refinery operations. This conclusion is supported by the fingerprint results which indicate the LNAPL is extremely weathered, "has lost its normal paraffins and most of its isoprenoid paraffins to biodegradation," and the fact that the LNAPL is found in only trace amounts in a fraction of the wells across the area or is not detected as depicted on AOC8-NF6 hydrographs in Appendix H. Groundwater results from wells at AOC8-NF6 have shown no exceedances of ethylbenzene, toluene, or xylenes. Benzene is the only BTEX compound that is detected above the delineation criteria in three of the six wells sampled semi annually (MW-128, RW-35, and RW-42). During the most recent sampling event in June 2007, benzene was detected at a concentration of 160 µg/L and 3J µg/L in RW-35 and RW-42, respectively, and was not detected in MW-128.

The fingerprint results, the lack of measurable LNAPL, and the minimal and isolated dissolved phase concentration in AOC8-NF6 suggest that the LNAPL impacts are historical and degradation is occurring.

6.51 Comment 51**RFI Section: 7.5, page 167, #3****Comment Letter Page: 8**

Chevron indicates that M133A1 was installed side gradient from the LNAPL area. This well later developed trace amounts of LNAPL. LNAPL has not been satisfactorily delineated in this area. Chevron must continue delineating free and residual NAPL in the area surrounding M133A1.

Chevron Response

Chevron would like to point out that two soil borings (S0837 and S0883) were advanced immediately adjacent and south of MW-133, respectively. Four soil samples collected from S0837 (Section A.2.34, Full RFI Report, November 2003) and S0883 (Section 5.2, PAOC Report, June 2007) revealed PAH exceedances in only one sample obtained at S0837. Chevron also initiated weekly monitoring of MW-133 and found that LNAPL detection is only observed at trace amounts (coating on an interface probe) as indicated on the hydrograph for MW-133 in Appendix H. Based on the minor LNAPL detections, Chevron has resumed semi-annual groundwater sampling at MW-133 for VOCs. The groundwater samples subsequently obtained from MW-133 have not shown any exceedances of the SRFI Evaluation Criteria. Groundwater results obtained from MW-133 are provided in Appendix G. Figure 42 depicts the boundary of the LNAPL plume, the location of MW-133 and soil borings S0837 and S0883.

Chevron believes MW-133 is located on the fringe of the LNAPL plume and based on the results of extensive LNAPL and groundwater monitoring, no additional delineation is required. Additionally, as discussed in the 2005 LNAPL Stabilization Measures Status Report, Chevron is performing weekly evacuation of total liquids at MW-133 to remove the trace amounts of LNAPL. Chevron proposes to continue focusing its efforts on LNAPL removal within the area.

6.52 Comment 52

RFI Section: 7.5, page 167, #4
Comment Letter Page: 8

Chevron indicates that the lateral extent of LNAPL at AOC 19 has been delineated. The Department cannot concur with this determination at this time. Additional delineation is required in the area surrounding M133A1 and A19TP7.

Chevron Response

Chevron believes MW-133 is located on the fringe of the AOC 19 LNAPL plume and based on the results of extensive LNAPL and groundwater monitoring, no additional delineation is required. LNAPL impacts at A19TP7 are associated with the AOC8-NF6 LNAPL Area, not AOC 19. Additional delineation was performed further downgradient of A19TP7, as part of the AOC 8-NF6 investigation. Please refer to the responses to Comments 51 and 53 for further discussion on LNAPL impacts at MW-133 and A19TP7.

6.53 Comment 53**RFI Section: 7.5, page 167, #5****Comment Letter Page: 8**

Chevron indicates that piezometer A19TP7 is located upgradient from the AOC8-NF6 NAPL area. However, according to figure 7-6, it appears that this piezometer is located downgradient from the NAPL area. The statement should be revised. Additional delineation of this NAPL is required both downgradient from A19TP7 and between the AOC8-NF6 area and this piezometer.

Chevron Response

Chevron acknowledges the Department's comment; however, the reference to A19TP7 (upgradient of AOC8-NF6) was only to point out that impacts at A19TP7 are associated with AOC8-NF6, not AOC 19. LNAPL is found at trace amounts as shown on the hydrograph in Appendix H. Additional delineation was performed further downgradient of A19TP7, as part of the AOC 8-NF6 investigation. Chevron would also like to point out that A19TP7 is located in an active process unit where access is extremely limited to the north, west, and south. As such, no additional points could be installed.

6.54 Comment 54

RFI Section: 7.5, page 167, last #
Comment Letter Page: 8

Chevron indicates that an additional piezometer will be installed south of MW-133 if only NAPL detection persists. The NJDEP cannot concur. A boring program shall be instituted to delineate the extent of free and residual NAPL in this area at this time. The Department is particularly concerned that this NAPL is found adjacent to the refinery sewer system. This may be a preferential pathway for NAPL and dissolved contaminant migration.

Chevron Response

As discussed in the response to Comment 51, Chevron believes MW-133 is located on the fringe of the AOC 19 LNAPL plume and based on the results of extensive LNAPL and groundwater monitoring, no additional delineation is required. Additionally, as described in the response to Comment 41 above, Chevron believes the OWSS, the primary underground piping system, has been adequately investigated during the Phase I and Phase II OWSS investigations. Impacts identified during the OWSS investigations were thoroughly delineated as part of the subsequent LNAPL Management Program and Full RFI. Therefore, no additional evaluation or investigation of the subsurface piping/utilities is warranted.

6.55 Comment 55**RFI Section: 7.6, page 177, 1st #****Comment Letter Page: 8**

Chevron indicates that "based upon the lack of VOCs and SVOCs within downgradient well MW-120, the dissolved phase plume appears to be stable". The Department cannot concur with this conclusion. Monitor well NF-11 and hydropunch sample H0310 both have elevated concentrations of benzene. These sampling points are located downgradient from the AOC 16/NF2 area. Chevron must complete delineation of the horizontal and vertical extent of this dissolved plume.

Chevron Response

Chevron has since installed six additional monitoring wells (MW-210, MW-211, MW-233, MW-234, MW-240, and MW-242) in the vicinity of the NF2 LNAPL Area. MW-240 was installed as a deep well to screen the deeper aquifer, and the remaining five wells were screened across the shallow aquifer. The location of monitoring wells and temporary well points in the vicinity of the NF2 LNAPL Area are shown on Figure 43.

Groundwater samples collected from MW-0057, MW-120, MW-210, MW-211, and MW-242 to date have shown that there are no VOC or SVOC exceedances of the SRFI Evaluation Criteria. Concentrations of bromodichloromethane and chloroform were noted above the SRFI Evaluation Criteria in the groundwater sample from MW-240. However, the sample did not show any exceedances of compounds typical of LNAPL impacts. These exceedances appear to be an anomaly and are typically by-products associated with the disinfection of municipal potable water supplies.

Chevron believes that the horizontal extent of the dissolved phase plume around the NF2 LNAPL area has been delineated with the surrounding temporary well points and monitoring wells MW-0057, MW-120, MW-210, MW-211, and MW-242, while the vertical extent has been delineated with MW-240.

6.56 Comment 56**RFI Section: 7.8, page 183, last #****Comment Letter Page: 9**

Chevron indicates that ground water flow direction at area NF4 is northeast toward Woodbridge Creek. However, Figure 8-10 shows a ground water depression between tanks 302, 328 and 330 and ground water flow in the area of tank 330 is toward that depression (toward the southeast). It may be that ground water flow in this area is controlled by subsurface utilities or by a downward vertical gradient in the area of NF-10. Chevron must determine the fate of ground water contamination in this area. Chevron shall install two additional monitoring wells between Tank 330 and MW-0070 at the approximate locations indicated on attached, modified figure 7-9.

Chevron Response

Chevron conducted a detailed assessment of on-site wells that are being used to determine groundwater flow direction site-wide. This assessment included categorizing each well based on the elevation of its well screen and its relationship with corresponding geologic units. Following this assessment, Chevron developed separate groundwater contour maps for the shallow and deep water-bearing units beneath the site. The most recent site-wide groundwater contour maps for shallow and deep groundwater depict groundwater generally flowing to the east, and slightly southeast, towards the Woodbridge Creek in the vicinity of Tanks 302, 328, and 330 (Figure 33 and Figure 34). Chevron believes there are an adequate number of wells in this area and additional wells are not needed to determine groundwater flow direction.

To address the vertical gradient concern in this area, existing deep monitoring well MW-187 was paired with shallow well NF-10 to investigate the hydrogeologic relationship between the first shallow and first native water-bearing zones across this area. A downward vertical hydraulic gradient of 0.04985 from shallow well NF-10 to deep well MW-187 was calculated from the February 2007 gauging data using the USEPA Site Assessment Calculations web-site, and is included in Appendix F.

Based on the boring logs from the MW-187 and NF-10 installations, both MW-187 and NF-10 intersect Clay Horizon A between 10.0 and 12.0 ft. bgs. In each boring, Clay Horizon A consists of approximately one foot of a light gray clayey silt or silty clay. Sand and gravel horizons above and below Clay Horizon A are encountered in each boring.

MW-187 was installed in place of MW-180, which was abandoned due to the fact that its screen was not properly placed during installation. As such, Chevron has only sampled deep well MW-187 once. On May 18, 2004, chloroform (14 µg/L) was the only compound detected in a concentration exceeding the SRFI Evaluation Criteria in MW-187. This compound is typically a sampling artifact, and is not associated with COCs in this area. Shallow well NF-10, has been sampled quarterly since 2004 to the present.

However, since MW-187 was last sampled in May 2004, Chevron compared it with NF-10 data collected on May 3, 2004 in this response. At that time, well NF-10 groundwater samples contained benzene (570 µg/L) and xylene (1,500 µg/L) at concentrations exceeding the SRFI Evaluation Criteria. The most recent groundwater gauging and sampling event conducted on May 22, 2007 yielded similar VOCs (benzene, 460 µg/L; cyclohexane, 270 µg/L; methylcyclohexane, 240 µg/L; and xylene, 1,100 µg/L) at concentrations exceeding the SRFI Evaluation Criteria. Despite evidence of a downward vertical gradient between shallow well NF-10 to deep well MW-187, the analytical data indicate the presence of relatively high concentrations of VOCs in NF-10, and that these contaminants are not migrating downward through Clay Horizon A to reach groundwater intercepted by deep well MW-187. Chevron plans to include well MW-187 in their groundwater monitoring program, which would include semi-annual sampling and quarterly gauging.

Based on Figure 37, higher concentrations (greater than 100 to 1,000 µg/L) of dissolved phase benzene appear to be isolated to the immediate NF-10 area, and lower concentrations (greater than 10 to 100 µg/L) extend south and east towards Tanks 327 and 326 (NF5 Area). Monitoring wells MW-258, MW-259, and MW-266 were installed in this vicinity as part of the CMS, and further information provided by these wells will be addressed in the CMS report as well.

6.57 Comment 57

RFI Section: 7.8, page 183, last #
Comment Letter Page: 9

The source of the LNAPL in area NF4 is not identified. Chevron shall identify the source of the LNAPL at NF4. Chevron shall add this source to the HSWA permit as a SWMU/AOC. Chevron shall determine if the source is continuing to release contaminants to the environment.

Chevron Response

As in other areas of the Refinery, the source of the NF4 LNAPL Area is historical and the source no longer exists. Extensive recovery and monitoring efforts at MW-0070 have shown a significant reduction in LNAPL detections, where LNAPL is only being detected occasionally in trace amounts (see the hydrograph for MW-0070 in Appendix H). Chevron's intent is to continue focusing on removal efforts at MW-0070.

6.58 Comment 58**RFI Section: 7.9, Figure 7-10****Comment Letter Page: 9**

Figure 7-10 shows ground water flow direction toward the Woodbridge Creek. This is contradicted by figure 8-10, which shows that ground water flow direction is toward an area between Tanks 327 and 301. Ground water flow direction and hence contaminant fate may be influenced by subsurface utilities. Chevron must more accurately determine the fate of contamination from AOC 16 Investigation Area NF5. Chevron shall install two monitor wells to more accurately determine local ground water flow direction. The wells shall be installed at the locations of NF5TP5 and NF5TP4. If it is found that local ground water flow is significantly different from that depicted on figure 7-10, then Chevron shall propose additional sampling to delineate contamination in the direction of ground water flow.

Chevron Response

Chevron conducted a detailed assessment of on-site wells which are being used to determine groundwater flow direction site-wide. This assessment included categorizing each well based on the elevation of its well screen and its relationship with corresponding geologic units. Following this assessment, Chevron developed separate groundwater contour maps for the shallow and deep water-bearing units beneath the site. The most recent site-wide groundwater contour maps for shallow and deep groundwater depict groundwater generally flowing to the east towards the Woodbridge Creek in the NF/MY Area (See Figure 33 and Figure 34). Chevron believes there are an adequate number of wells in this area and additional wells are not needed to determine groundwater flow direction.

As depicted on Figure 33, recent shallow groundwater flow direction in the vicinity of Tanks 301 and 327 indicates a groundwater depression around them. No additional shallow wells were installed in this area during the SRFI for purposes of COC delineation or to determine groundwater flow direction. During the SRFI, one deep monitoring well (MW-238) was installed between Tanks 301 and 327 to be paired with existing shallow well MW-117 (see Comment 2). During the CMS, four shallow wells (MW-260, MW-261, MW-267, and MW-273) were installed in this area. Analytical and gauging data from these four CMS wells were used to generate Figure 33 and Figure 37.

Based on this recent data, Chevron believes the NF5 LNAPL Area has been adequately delineated regardless of groundwater flow direction. Furthermore, based on a reduction in LNAPL detection within MW-0071, as illustrated in the attached hydrograph (Appendix H), Chevron has included MW-0071 in the groundwater monitoring program for VOCs. Groundwater samples collected from MW-0071 have shown exceedances for benzene, cyclohexane, and methylcyclohexane. Chevron will reevaluate the need for additional wells at the location of NF5TP4 and NF5TP5 if warranted by the field screening or groundwater results from MW-0071.

6.59 Comment 59**RFI Section: 7.10, page 192, #2****Comment Letter Page: 9**

The Overview and Location section does not identify the source of the LNAPL in this area. The source of the LNAPL must be identified and added to the HSWA permit as a SWMU/AOC. Construction details and materials handled at the source need to be outlined in the report. This information is required to evaluate the completeness of the investigations performed in this area to date.

Chevron Response

The source of the LNAPL at AOC 25 is historical, and the source no longer exists. As shown on the attached Figure 44, Chevron has performed extensive delineation efforts at AOC 25 to define the LNAPL area and reasserts that there are no ongoing sources. Additionally, extensive recovery and monitoring efforts at AOC 25 have shown a significant reduction in LNAPL detections within the monitoring wells and it is Chevron's intent to continue to focus on LNAPL removal efforts.

6.60 Comment 60**RFI Section: 7.10, Figure 7-11****Comment Letter Page: 9**

The Department notes that free product was detected in sample TPZM371 located within 20 feet of the SAR. No additional samples were taken directly downgradient of the SAR Trailer. Therefore, Chevron shall install 3 monitoring wells immediately downgradient from the western-most SAR trailer (as depicted on figure 7-11). These wells shall screen the water table aquifer.

Chevron Response

A groundwater sample was obtained from temporary well H0837 downgradient of AOC 25 and was analyzed for VOCs and SVOCs (see Table 45). The results revealed no exceedances of the SRFI Evaluation Criteria. Chevron has since installed a permanent monitoring well (MW-190) downgradient of AOC 25 and added it to the monitoring program for VOCs and SVOCs. Please see Figure 44 for the locations of H0837 and MW-190. Groundwater samples obtained from MW-190 to date have not revealed any exceedances of the SRFI Evaluation Criteria. Chevron is unable to install a monitoring well immediately north of the SAR Trailers because of high voltage underground utilities. Chevron notes that only a trace amount (coating on the interface probe) of LNAPL was observed at TPZM371 and believes MW-190 provides adequate downgradient monitoring for AOC 25. In addition, Chevron has also initiated groundwater sampling at monitoring wells MW-0054 and MW-0056 for VOCs and SVOCs. Results have shown maximum benzene concentrations of 360 µg/L and 38 µg/L at MW-0054 and MW-0056, respectively. Chevron plans to continue semi-annual groundwater sampling for VOCs at MW-0054 and MW-0056. Groundwater results obtained from MW-0054, MW-0056, and MW-190 are included in Appendix G.

Table 45. H0837 Data (November 19, 2002)

TCL VOCs (µg/L)			
1,1,1-Trichloroethane	0.8U	Chloroethane	1U
1,1,2,2-Tetrachloroethane	1U	Chloroform	0.8U
1,1,2-Trichloroethane	0.8U	Chloromethane	1U
1,1-Dichloroethane	1U	cis-1,2-Dichloroethene	0.8U
1,1-Dichloroethene	0.8U	cis-1,3-Dichloropropene	1U
1,2,4-Trichlorobenzene	1U	Cyclohexane	2U
1,2-Dibromo-3-chloropropane	2U	Dibromochloromethane	1U
1,2-Dibromoethane	1U	Dichlorodifluoromethane	2U
1,2-Dichlorobenzene	1U	Ethylbenzene	1J
1,2-Dichloroethane	1U	Freon 113	2U
1,2-Dichloropropane	1U	Isopropylbenzene	1U
1,3-Dichlorobenzene	1U	Methyl acetate	1U
1,4-Dichlorobenzene	1U	Methyl-t-butyl ether	0.5U
2-Butanone	3U	Methylcyclohexane	1U

Table 45. H0837 Data (November 19, 2002)

2-Hexanone	3U	Methylene chloride	2U
4-Methyl-2-pentanone	3U	Styrene	1U
Acetone	6U	Tetrachloroethene	0.8U
Benzene	0.5U	Toluene	0.7U
Bromodichloromethane	1U	trans-1,2-Dichloroethene	0.8U
Bromoform	1U	trans-1,3-Dichloropropene	1U
Bromomethane	1U	Trichloroethene	1U
Carbon Disulfide	1U	Trichlorofluoromethane	2U
Carbon Tetrachloride	1U	Vinyl chloride	1U
Chlorobenzene	0.8U	Xylenes, Total	0.8U
TCL SVOCs (µg/L)			
2,4,5-Trichlorophenol	1U	bis(2-Chloroethyl) ether	1U
2,4,6-Trichlorophenol	1U	Bis(2-chloroisopropyl) ether	1U
2,4-Dichlorophenol	1U	bis(2-Ethylhexyl)phthalate	2U
2,4-Dimethylphenol	1U	Butylbenzylphthalate	2U
2,4-Dinitrophenol	21U	Caprolactam	5U
2,4-Dinitrotoluene	1U	Carbazole	1U
2,6-Dinitrotoluene	1U	Chrysene	1U
2-Chloronaphthalene	1U	Di-n-butylphthalate	2U
2-Chlorophenol	1U	Di-n-octylphthalate	2U
2-Methyl-naphthalene	9J	Dibenz(a,h)anthracene	1U
2-Methylphenol	1U	Dibenzofuran	1U
2-Nitroaniline	1U	Diethylphthalate	2U
2-Nitrophenol	1U	Dimethylphthalate	2U
3,3'-Dichlorobenzidine	1U	Biphenyl	1U
3-Nitroaniline	1U	Fluoranthene	1U
4,6-Dinitro-2-methylphenol	5U	Fluorene	1U
4-Chloroaniline	1U	Hexachlorobenzene	1U
4-Chlorophenyl phenyl ether	1U	Hexachlorobutadiene	1U
4-Nitroaniline	1U	Hexachlorocyclopentadiene	5U
4-Nitrophenol	10U	Hexachloroethane	1U
Acenaphthene	1U	Indeno(1,2,3-cd)pyrene	1U
Acenaphthylene	1U	Isophorone	1U
Acetophenone	2U	N-Nitrosodi-n-propylamine	1U
Anthracene	1U	N-Nitrosodiphenylamine	2U
Atrazine	1U	Naphthalene	1U
Benzaldehyde	1U	Nitrobenzene	1U
Benzo(a)anthracene	1U	p-Chloro-m-cresol	1U
Benzo(a)Pyrene	1U	p-Cresol	2U
Benzo(b)Fluoranthene	1U	Pentachlorophenol	3U
Benzo(g,h,i)perylene	1U	Phenanthrene	2J
Benzo(k)Fluoranthene	1U	Phenol	1U
bis(2-Chloroethoxy)methane	1U	Pyrene	1U

6.61 Comment 61**RFI Section: 7.10****Comment Letter Page: 9**

It is noted that the free product found near the SAR trailers could cause an indoor air quality problem. Chevron shall determine if indoor air in the SAR trailers is compromised due to the potential presence of free product in the area.

Chevron Response

Chevron notes the Department's concern about indoor air in the SAR trailers. However, Chevron does not believe vapor intrusion is a concern in this area. The SAR trailers are elevated, temporary structures with a two foot gap between the bottom of the trailer and ground surface. In addition, only a trace of product (coating on an interface probe) was observed in TPZM371 and groundwater is present at or below 7 ft. bgs.

6.62 Comment 62**RFI Section: 7.10, page 199, #5****Comment Letter Page: 9**

Chevron indicates that the lateral extent of LNAPL has been delineated. The Department cannot concur at this time. Additional monitoring wells need to be installed to complete delineation in this area.

Chevron Response

As discussed in the response to Comment 60, Chevron has installed a permanent monitoring well (MW-190) downgradient of the AOC 25 LNAPL Area to monitor groundwater and to complete the lateral delineation of LNAPL at AOC 25. To date, LNAPL has not been detected within MW-190 and the groundwater samples collected from MW-190 have not shown any exceedances of the SRFI Evaluation Criteria.

6.63 Comment 63**RFI Section: 7.11, page 207, #3****Comment Letter Page: 9**

Chevron shall install three permanent monitoring wells downgradient from the free product area to confirm local ground water flow direction and to monitor contaminant migration in the area. The wells shall be installed in the locations shown on attached modified Figure 7-12 from the report and shall be constructed to screen the water table.

Chevron Response

Since the Full RFI, Chevron has installed five additional shallow permanent monitoring wells (MW-208, MW-209, MW-227, MW-228, and MW-229) in the vicinity of SWMU 42 between 2004 and 2005. In addition, two temporary wells (H1001 and H1002) and two shallow permanent monitoring wells (MW-236 and MW-245) in AOI 1 were installed in this area during the SRFI in 2006 (see Section 5.4.1). Most recently, in 2007, one shallow permanent monitoring well (MW-272) was installed at SWMU 42 during the CMS. All of these wells are depicted on Figure 37. Figure 37 depicts the extent of benzene in groundwater based on 2007 groundwater sampling data and historical temporary well groundwater data. As such, Chevron believes there are adequate wells in the area to determine groundwater flow direction and has confirmed groundwater flow toward the northwest.

Additionally, as indicated on the attached hydrograph for MW-0051 (Appendix H), only intermittent trace amounts of LNAPL are currently being detected at MW-0051. Chevron has included MW-0051 in the groundwater monitoring program and is conducting semi-annual groundwater sampling at MW-0051. To date, a total of eight samples have been collected from MW-0051 and analyzed for TCL VOCs. Six of the eight samples revealed benzene concentrations ranging from 9 µg/L to 46 µg/L, while the remaining two samples revealed benzene at 250 µg/L and 350 µg/L. Analytical results obtained from MW-0051 are provided in Appendix G.

Chevron would like to point out that this area is located in one of the most active areas of the Refinery and as such, access is extremely limited. Chevron believes that the area has been adequately delineated and proposes to continue the groundwater sampling effort at MW-0051.

6.64 Comment 64**RFI Section: 7.12, page 212, #3****Comment Letter Page: 10**

Chevron indicates that caprolactam and bis(2-ethylhexyl)phthalate may result from latex gloves and the nylon cord used in ground water sampling. If this is the case, these parameters should show up in the method blank. Chevron shall submit a discussion of the method blank lab results to confirm their theory.

NOTE: Caprolactam is a white crystalline solid with an unpleasant odor. It is used in making nylon, plastics, coatings, and synthetic leather.

Chevron Response

Through the Full RFI sampling effort, caprolactam was detected in samples collected from temporary well points H0834 and H0843, and from monitoring wells MW-101, MW-102, and RW-42 in excess of the SRFI Evaluation Criteria (100 µg/L).

According to the USEPA Air Toxics Website (2007a), caprolactam is used in the manufacture of synthetic fibers such as Nylon 6, and is also used to make plastics. Chevron believes the exceedances of caprolactam in RFI groundwater samples to be the result of intermittent contamination occurring through the use of materials such as nylon cord and latex gloves during sampling. This theory is supported by the fact that caprolactam has not been detected in subsequent post-RFI groundwater samples collected from the permanent monitoring wells (MW-101, MW-102, and RW-42) as shown in Table 46. The data does not indicate a consistent caprolactam presence, which would be expected if the contamination originated in the groundwater itself. In addition, these intermittent occurrences of caprolactam seem to appear at random locations throughout the Refinery. The temporary well points H0834 and H0843 were located in the EY at SWMU 42. Monitoring wells MW-101 and MW-102 are located in the CY at SWMU 34 and AOC 22 respectively. Monitoring well RW-42 is located in the MY at AOC 8.

Unlike the permanent monitoring wells, the temporary well points H0834 and H0843, located in the EY1 LNAPL Area (SWMU 42), cannot be resampled. However, groundwater samples collected from permanent monitoring wells RW-61 and MW-152 (also located in the EY1 LNAPL Area), do not indicate the presence of caprolactam in excess of the SRFI Evaluation Criteria (please see Table 47).

Through the Full RFI sampling effort, DEHP was detected in samples collected from permanent monitoring wells MW-44, MW-65, MW-152, and P-4 in excess of SRFI Evaluation Criteria (30 µg/L).

DEHP is primarily used to make PVC. Chevron believes the exceedances of DEHP in RFI groundwater samples to be the result of contamination occurring through the use of materials such as PVC bailers during sampling. This theory is supported by the fact that

Table 46. Caprolactam Results In Permanent Monitoring Wells

Sample ID	Sample Type	Date(s)	Caprolactam (µg/L)
MW-101			
M101A1	RFI	10/10/02	110
M101A1	RFI	10/11/02	250
M101A2	Post-RFI	3/24/03 & 3/26/03	5U
M101A3	Post-RFI	7/12/04 & 7/13/04	5U
M101A4	Post-RFI	10/11/04 & 10/12/04	5U
MW-102			
M102A1	RFI	10/14/02	5J
M102A2	RFI	1/30/03	190
M102A3	Post-RFI	2/23/04	5U
M102A4	Post-RFI	7/8/04	5U
M102A5	Post-RFI	10/18/04 & 10/19/04	5U
RW-42			
RW42A1	RFI	11/4/02	270
RW42A2	Post-RFI	9/28/04 & 9/29/04	5U

Shaded cells indicate RFI samples in which caprolactam was first detected.

Table 47. Caprolactam Results In Temporary Well Points and Supporting Permanent Monitoring Well Data

Sample ID	Sample Type	Date(s)	Caprolactam (µg/L)
Temporary Well Points			
H0834	RFI	9/4/02	400
H0843	RFI	11/13/02	210
RW-61			
RW61A1	RFI	10/29/02	5U
R061A2	Post-RFI	7/24/03	65
R061A3	Post-RFI	11/5/03	5U
R061A4	Post-RFI	8/24/04 & 8/25/04	5U
R061A5	Post-RFI	11/29/04 & 11/30/04	5U
MW-152			
M152A1	RFI	10/7/02 & 10/8/02	5U
M152A2	RFI	1/22/03 & 1/23/03	5U
M152A3	Post-RFI	6/18/03	5U
M152A4	Post-RFI	11/20/03 & 11/21/03	5U

Shaded cells indicate RFI samples in which caprolactam was first detected.

DEHP has not been detected in excess of the SRFI Evaluation Criteria in subsequent RFI and post-RFI groundwater samples collected from these monitoring wells (please see Table 48). The data does not indicate a consistent DEHP presence, which would be expected if the contamination originated in the groundwater itself. As with the occurrences of caprolactam, the intermittent occurrences of DEHP seemed to appear at random locations throughout the Refinery. Monitoring well MW-44 is located in the CY in AOC 22. Monitoring wells MW-65 and P-4 are located in the NF/MY in SWMU 43/SWMU 5 and SWMU 51 respectively. Monitoring well MW-152 is located in the EY in SWMU 42.

Table 48. DEHP Results In Permanent Monitoring Wells

Sample ID	Sample Type	Date(s)	DEHP (µg/L)
MW-44			
M044A1	RFI	10/22/02	91
M044A2	RFI	3/6/03 & 3/11/03	2U
M044A3	Post-RFI	2/19/04	2U
M044A4	Post-RFI	7/7/04	2U
M044A5	Post-RFI	10/18/04 & 10/19/04	3J
MW-65			
M065A1	RFI	10/29/02	91
M065A2	Post-RFI	9/27/04 & 9/28/04	2U
MW-152			
M152A1	RFI	10/7/02 & 10/8/02	310
M152A2	RFI	1/22/03 & 1/23/03	2U
M152A3	Post-RFI	6/18/03	2U
M152A4	Post-RFI	11/20/03 & 11/21/03	2U
P-4			
P004A1	RFI	10/15/02 & 10/17/02	45
P004A2	Post-RFI	2/3/03 & 2/4/03	2U

Shaded cells indicate RFI samples in which DEHP was first detected.

Elevated concentrations of caprolactam and DEHP would not be expected in method blanks as the NJDEP asserts. Method blanks are laboratory equipment blanks collected to ensure that groundwater samples submitted for analysis are not being contaminated by the laboratory during the analytical process. It is Chevron's belief that elevated concentrations of caprolactam and DEHP are the result of intermittent field contamination; therefore, elevated concentrations of these compounds may be expected in the field blanks, not the method blanks. A review of the method blanks associated with the samples discussed above confirmed that there were no detections of caprolactam or DEHP. A review of the field blanks associated with the samples discussed above revealed two instances of DEHP concentrations in excess of the SRFI Evaluation Criteria (please see Table 49).

Table 49. DEHP Detections in Field Blanks

Sample ID	Sample Date	Field Blank ID	Field Blank Concentration (µg/L)
M044A1	10/22/02	F1022023	200
P004A1	10/11/02	F1017021	260

The intermittent nature of the field contamination of groundwater samples with caprolactam and DEHP means that there may be detections of these compounds in groundwater samples without matching detections in field blank samples.

Chevron does not believe the intermittent detection of caprolactam and DEHP in groundwater samples requires further investigation.

6.65 Comment 65**RFI Section: 7.13, Figure 7-14****Comment Letter Page: 10**

Figure 7-14 indicates that ground water flow in this area is radial. Chevron shall install five additional monitor wells at the locations specified on attached modified Figure 7-14. The wells shall screen the water table aquifer. The wells are required to better define local ground water flow direction so that a final determination concerning the need for additional delineation in the area may be made.

Chevron Response

Chevron conducted a detailed assessment of on-site wells which are used to determine groundwater flow direction site-wide. This assessment included categorizing each well based on the elevation of its well screen and its relationship with corresponding geologic units. Following this assessment, Chevron developed separate groundwater contour maps for the shallow and deep water-bearing units beneath the site. Chevron has provided a revised map of the EY3 LNAPL Area which shows a total of eight monitoring wells located around the EY3 LNAPL Area (see Figure 46). Subsequent to the original RFI, six additional wells have been installed in the vicinity of Tank 752 to address Comment 65 and better define local groundwater flow direction. Monitoring wells MW-141, MW-142, MW-143 and MW-178 were installed prior to the SRFI, and MW-248 and MW-249 were installed more recently as part of the SRFI. A detailed well construction log for each SRFI monitoring well location is included in Appendix B.

Based on gauging data collected from these wells since their installation, groundwater flow direction at the EY3 LNAPL Area has since been confirmed toward the northeast (see Figure 33).

Additionally, based on the lack of LNAPL detection within MW-157, as illustrated in the attached hydrograph (Appendix H), Chevron has included MW-157 in its groundwater monitoring program for TCL VOCs. Nine groundwater samples collected from MW-157 have shown benzene to be the only compound to exceed the SRFI Evaluation Criteria at a maximum concentration of 5J µg/L.

Semi-annual groundwater sampling at these wells has not shown any exceedances for VOCs or SVOCs (See Appendix G). Chevron believes that the EY3 LNAPL Area has been delineated and is being adequately monitored with the surrounding wells (see Figure 35 through Figure 40). Chevron will evaluate the need for additional wells during the CMS.

6.66 Comment 66**RFI Section: 7.13, page 219, #1****Comment Letter Page: 10**

Chevron indicates that benzene was detected in MW-157 at a relatively low concentration. Chevron argues that this suggests that degradation of dissolved phase constituents is occurring. However, the Department notes that a concentration of benzene (380 ug/L) was detected at sampling point H0836 located downgradient from MW-157. Additional delineation of this contamination is required.

Chevron Response

With specific regard to Comment 66, temporary well H0836 is downgradient of MW-157 and does indicate a higher concentration of benzene. However, historical data from further downgradient temporary wells H0400, H0890, and H0901, and permanent wells MW-10 and MW-142 do not indicate the presence of VOCs. At the same time, Chevron recognizes that temporary well H0477 (installed in 1999) did exhibit a benzene concentration of 8,200 µg/L. Please see Comment 71 for a discussion of temporary well data versus permanent well data concerns.

Additional monitoring wells MW-141, MW-142, and MW-143 were installed downgradient to the north, east, and south of MW-157, and downgradient from H0836, between August 19 and August 28, 2002. The most recent groundwater data collected from these wells on March 28, 2007 (MW-143), March 30, 2007 (MW-142), and April 23, 2007 (MW-141), indicate no VOCs or SVOCs in concentrations exceeding the SRFI Evaluation Criteria. Figure 37 indicates that the horizontal extent of dissolved benzene greater than 1 µg/L does not extend beyond wells MW-141, MW-142, and MW-143.

Based on these data, other surrounding temporary and permanent well data, and the fact that this area is not near a property boundary, Chevron feels that the delineation of VOCs in this area is sufficient.

6.67 Comment 67**RFI Section: 7.14, page 229, #5****Comment Letter Page: 10**

Chevron states that the lack of dissolved phase VOC and SVOC in recovery well RW-94 suggests that the EY4a LNAPL does not extend beyond the location of RW-94. To confirm that contamination is not migrating away from the LNAPL area, Chevron shall install three monitor wells for the purpose of monitoring ground water quality in the area surrounding the LNAPL found in Area EY4a. The monitor wells shall be installed at the locations of H0388, H0354 and H0386. The wells shall be constructed to screen the water table.

Chevron Response

In response, Chevron installed two permanent groundwater monitoring wells (MW-256 and MW-257) in the vicinity of temporary wells H0354, H0386, and H0388 during the SRFI (see Section 5.4.3). These two wells were screened in the upper water-bearing zone in the fill with five foot screens set across the water table.

As depicted on Figure 33, the direction of groundwater flow in this area is generally east-southeast. The average gradient across the area was calculated to be 0.008121, and the average flow direction was 124.3 degrees from north (east-southeast), based upon data collected during the February 2007 site-wide gauging event. As shown on Figure 33, sheet piling is evident downgradient of this area along the Arthur Kill.

During the SRFI, groundwater samples were collected from new wells MW-256, MW-257, and existing nearby wells. The results of this sampling is depicted in several SRFI COC site-wide distribution maps, which include arsenic, ammonia, benzene, cyclohexane, lead, and methylcyclohexane (see Figure 35 through Figure 40, respectively). Appendix G presents all laboratory analytical data for all groundwater monitoring wells, including dissolved metals concentrations, and their respective SRFI Evaluation Criteria.

A groundwater sample collected from well MW-256 (M256A1) contained SRFI Evaluation Criteria exceedances for VOCs and SVOCs. However, a groundwater sample from well MW-257 (M257A1) did not. Well MW-256 contained dissolved VOCs benzene (9 µg/L) and methylcyclohexane (130 µg/L) in concentrations exceeding the SRFI Evaluation Criteria (1 µg/L and 100µg/L, respectively). In addition, sample M256A1 contained dissolved SVOCs benzo(a)anthracene (3 µg/L), benzo(a)pyrene (3 µg/L), benzo(b)fluoranthene (3 µg/L), benzo(k)fluoranthene (1 µg/L) and indeno(1,2,3-cd)pyrene (1 µg/L) in concentrations exceeding the SRFI Evaluation Criteria (0.1 µg/L, 0.1 µg/L, 0.2 µg/L, 0.5 µg/L, and 0.2 µg/L, respectively).

There were several dissolved metals in concentrations exceeding the SRFI Evaluation Criteria for samples collected from MW-256 and MW-257. Samples from both

monitoring wells contained concentrations of arsenic, iron, lead, manganese, and sodium in excess of the SRFI Evaluation Criteria. Figure 36 and Figure 39 illustrate the extent of arsenic and lead contamination in AOI 3 shallow monitoring wells. Both plumes reach the sheet piling downgradient of AOI 3 along the Arthur Kill. The arsenic plume also reaches Chevron's property line in the southeastern corner of the EY with the ASARCO property.

Based on these findings and the presence of a downgradient sheet piling between the Arthur Kill and AOI 3, Chevron believes that it has sufficiently characterized and delineated groundwater quality in this area. Chevron will continue to monitor and computer model this area to determine if additional monitoring wells are necessary. However, Chevron believes that sufficient information is available now to develop remedial measures during the CMS.

6.68 Comment 68**RFI Section: 7.15, page 239, #3****Comment Letter Page: 10**

Chevron indicates that groundwater has been impacted by NAPL in this area and that these dissolved contaminants are limited and stable. Additional monitor wells are required to provide better definition of local ground water flow patterns and to monitor dissolved contamination emanating from this NAPL area. The wells shall be installed at the locations of H0342, H0389 and EY4TP44. The wells shall screen the water table.

Chevron Response

As presented in Section 5.4.2 (EY Area AOI 2), during the SRFI, Chevron installed one temporary well (H1005) and three permanent monitoring wells (MW-253, MW-254, and MW-255) in the vicinity of the AOC 16 EY4b LNAPL Area to provide better definition of local groundwater flow patterns and to monitor COCs. Temporary Well H1005 was installed northwest of H0342 across the water table. Wells MW-253 and MW-254 are shallow wells screened across the water table northeast of H0342 and H0389, respectively. Well MW-255 is a deep well located near existing well MW-149, screened in the first water-bearing zone beneath the fill and Clay Horizon A.

Site-wide shallow groundwater contour maps from 2003 (see Figure 32) indicate average groundwater flow direction across the entire AOI 2 Area is generally east-northeast, towards the Woodbridge Creek. The February 2007 shallow groundwater contour map (see Figure 33) confirms groundwater flow direction is generally east-northeast in this area. The average gradient across the area was calculated to be 0.01212, and average flow direction was 54.06 degrees from north (north-northeast), based upon data collected during the February 2007 site-wide gauging event.

The deep groundwater contour map generated from the February 2007 site-wide gauging data (Figure 34), indicates that groundwater flow across AOI 2 is generally east-northeast, towards the Woodbridge Creek. Deep groundwater flow across the area occurs within the first water-bearing zone of the native material, and flows under an average gradient of 0.00947.

One deep monitoring well (MW-255) was installed within AOI 2 during the SRFI. This well was paired with a previously installed shallow well (MW-149) to investigate the hydrogeologic relationships between the first shallow and first native water-bearing zones across the AOI 2 Area. For the well pair MW-149 (shallow screened) and MW-255 (deeper screened), a downward vertical gradient of 0.09290 was calculated. Based upon the boring logs from the MW-149 and MW-255 installations, both wells intersect an organic silt horizon with peat and root fragments between 12.0 and 14.0 ft. bgs. The description of the sediments below this interval in MW-255 indicates organic and inorganic silty clay extends to the screen interval, where a medium to coarse sand was intersected. According to the boring log, the well was cased at 17.0 ft. bgs, five feet into

the clay horizon. The boring log information suggests that a sufficient confining layer exists between the first shallow water-bearing zone and the first native water-bearing zone.

During the SRFI, groundwater samples were collected from these new SRFI wells and existing nearby wells. The results of this sampling is depicted in several SRFI COC site-wide distribution maps which includes arsenic, ammonia, benzene, cyclohexane, lead, and methylcyclohexane (see Figure 35 through Figure 40, respectively). Appendix G presents all laboratory analytical data for all groundwater monitoring wells, including dissolved metals concentrations, and their respective SRFI Evaluation Criteria.

The groundwater grab sample H1005, collected from the temporary well H1005 in AOI 2 contained concentrations of VOCs in excess of the SRFI Evaluation Criteria. Sample H1005 contained benzene (10 µg/L), cyclohexane (590 µg/L), ethylbenzene (780 µg/L), and methylcyclohexane (420 µg/L) in excess of the SRFI Evaluation Criteria (1 µg/L, 100 µg/L, 700 µg/L and 100 µg/L, respectively), and was collected from a two foot screen interval, set 9.5 to 11.5 ft. bgs.

Groundwater sample M253A1 contained no VOCs, but contained SVOCs benzo(a)anthracene (2 µg/L), benzo(a)pyrene (2 µg/L), and benzo(b)fluoranthene (2 µg/L), in concentrations exceeding the SRFI Evaluation Criteria (0.1 µg/L, 0.1 µg/L, and 0.2 µg/L, respectively).

Groundwater sample M254A1 contained dissolved VOCs benzene (17 µg/L) and methylcyclohexane (170 µg/L) in concentrations exceeding the SRFI Evaluation Criteria (1 µg/L and 100 µg/L, respectively). This sample contained no dissolved SVOCs.

There were several dissolved metals in concentrations exceeding the SRFI Evaluation Criteria for samples collected from MW-253 and MW-254. Samples from both monitoring wells contained concentrations of arsenic, iron, manganese, and sodium exceeding the SRFI Evaluation Criteria. Additionally, groundwater sample M253A1 contained dissolved concentrations of aluminum, cobalt, and nickel above the SRFI Evaluation Criteria.

A groundwater sample was collected at deep well MW-255 and analyzed for VOCs, SVOCs, and metals. This groundwater sample contained no dissolved VOCs or SVOCs in concentrations exceeding the SRFI Evaluation Criteria. Monitoring well MW-255 had concentrations of dissolved aluminum, iron, manganese, and sodium exceeding the SRFI Evaluation Criteria.

Based on the SRFI findings, no additional wells are necessary in this area. Chevron plans to continue monitoring these wells and provide updates to EPA and NJDEP quarterly.

6.69 Comment 69**RFI Section: 7.16, page 239, #5****Comment Letter Page: 10**

Chevron indicates that the LNAPL was identified in the footprint of Tank 719 which was used to store a Refinery intermediate distillate product used in asphalt production. On pg. 240, Chevron indicates that a sample of the product could not be collected due to insufficient LNAPL volume. Chevron shall present a list of all chemicals that were stored in the vicinity of AOC 28. Chevron shall indicate if the analyses performed on ground water samples were sufficient to detect chemicals that may have been released from the tanks in the general vicinity of AOC 28.

Chevron Response

AOC 28 is located in the EY, and consists of petroleum impacted soils associated with former Tank 718 and Tank 719 and an adjacent pump pad. Chevron notified the USEPA and NJDEP of AOC 28 in a correspondence dated June 10, 1999. A subsequent SAR was submitted on August 31, 1999. The SAR states that these tanks were used to store and transport No. 2 oil used in the production of asphalt, and that they were demolished in March 1999.

Other storage tanks in the vicinity of AOC 28 were used to store asphalt and other petroleum products as presented in Table 50.

Groundwater samples collected at AOC 28 were analyzed for TCL VOCs and TCL SVOCs. The TCL list has been shown in the past to adequately characterize asphalt and other petroleum contamination in groundwater, and as such, is adequate to characterize potential contamination from the identified surrounding chemical storage locations.

Table 50. Chemical Storage In The Vicinity of AOC 28

Tank No.	Location Relative to AOC 28	Past Products in Storage	Current Status
704	Southwest	Air Blown Asphalt (Roll Saturant)	Demolition Complete
705	Southwest	Air Blown Asphalt (Roll Saturant)	Demolition Complete
706	Southwest	Asphalt	Demolition Complete
707	Southwest	Asphalt	Demolition Complete
708	Southwest	Asphalt Blend (Flux), Asphalt	Demolition Complete
710	West	Air Blown Asphalt (Roll Saturant)	Demolition Complete
711	West	Air Blown Asphalt (Roll Saturant)	Demolition Complete
712	West	Asphalt Blend (MC-400) w/Additive	Demolition Complete
713	West	Asphalt Blend (MC-70)	Demolition Complete
714	West	Asphalt Blend (MC-70)	Demolition Complete
715	West	Asphalt Blend (MC-250)	Demolition Complete
716	West	Asphalt Blend (MC-250) w/Additive	Demolition Complete
717	West	Asphalt Blend (MC-250) w/Additive	Demolition Complete
720	North	Air Blown Asphalt (Shingle Saturant), Recovered Lube Oil, Asphalt	In Use (Asphalt Storage)
721	North	Air Blown Asphalt Shingle Saturant, Asphalt	In Use (Asphalt Storage)
722	North	Asphalt Blend - MC-400, Asphalt	In Use (Asphalt Storage)
731	Southeast	Asphalt	In Use (Asphalt Storage)
732	South	Asphalt Emulsion Plant Stock	Demolition Complete
733	South	Asphalt Emulsion Plant Stock	Demolition Complete
734	South	Asphalt Emulsion Plant Stock, IAF Float & Distillate Mix	Demolition Complete
735	South	Asphalt Emulsion Plant Stock, IAF Float & Distillate Mix	Demolition Complete
736	South	Asphalt Emulsion Plant Stock, IAF Float & Distillate Mix	Demolition Complete

6.70 Comment 70**RFI Section: 7.17, page 247, #4****Comment Letter Page: 10**

The vertical extent of free and residual NAPL has not been delineated in this area (according to table 7-75). Chevron shall propose additional investigations to determine the vertical extent of free and residual NAPL in this area.

The viscosity and specific gravity of the NAPL found in this area must be reported. All findings must be reported including any findings of dense non-aqueous phase liquid found in this area.

Chevron Response

Chevron has performed additional investigation within AOC 29 as part of a Remedial Alternatives Evaluation and the SRFI. Five additional soil borings: P-1 and P-2 (advanced for geotechnical observations and testing), and S2336, S2337, and S2434 (advanced to complete vertical delineation within AOC 29) have confirmed the vertical extent of free and residual LNAPL (Figure 47). The borings were advanced to depths ranging from 25.0 to 80.0 ft. bgs. As indicated by boring logs P-1, P-2, S2336, S2337, and S2434 (included in Appendix B), vertical delineation has been achieved at 25.0 ft. bgs. Three soil samples were obtained from soil borings S2336, S2337, and S2434 for laboratory analyses of VOCs and SVOCs. The samples were obtained from 14.5 to 15.0 ft. bgs at S2336 and S2337 and from 24.5 to 25.0 ft. bgs at S2423. Laboratory results indicate PAH exceedances of the SRFI Evaluation Criteria in samples obtained from S2236 and S2337. There were no exceedances in the sample obtained from S2434. A summary of the analytical data obtained from S2236, S2337, and S2434 is provided in Appendix D. Based on the field observations and laboratory results from the recent investigation, Chevron believes vertical delineation has been completed at AOC 29.

Fingerprint results obtained from AOC 29 is provided in Appendix I. In addition, the following is a summary of the events, investigations, and submittals associated with AOC 29 to date (documents completed by Chevron and submitted to the USEPA and NJDEP are italicized).

- April 20, 1999 - Black hardened material similar to “asphalt” was identified at 5 Berth. A sample was submitted for fingerprinting and the material was deemed coal tar.
- August 27, 1999 – The 5 Berth area was designated as AOC 29 in a *Letter of Notification* to USEPA and NJDEP.
- December 1999 – A *Site Assessment Report* which provided a description of the unit and a *Sampling Analysis Plan (SAP)* prepared to investigate groundwater were submitted to USEPA and NJDEP. A copy of the laboratory report was included as Attachment 1 of the SAR.

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- June 25, 2001 - LNAPL fingerprinted as weathered No.2 diesel oil was identified during the groundwater investigation. The specific gravity of the material was reported as 0.9182. The viscosity of the material could not be determined because the required volume of LNAPL could not be obtained due to only trace volume of LNAPL detected in the temporary well point. A copy of the Laboratory Report was submitted in Appendix A of the *LNAPL Management Plan*.
 - September 19, 2002 - The *LNAPL Management Plan* was submitted to the USEPA and NJDEP, which provided Chevron's approach to address LNAPL at the Refinery. The Plan was prepared with the understanding that AOC 29 contained coal tar which would have likely been removed and a portion of the LNAPL impacted soil would have likely been remediated at that time. Chevron proposed to re-evaluate the area after those activities were completed. However, as discussed in the *Full RFI Report*, the site characteristics and the remedial approach have changed upon further investigation and laboratory analyses.
 - 1st Quarter 2003 - Additional field investigations and laboratory analyses of the black "asphalt" material identified the black material as heavy oil not "coal tar". Chevron discussed these findings and received concurrence from the USEPA/NJDEP during a Full RFI meeting on August 18, 2003.
 - December 10, 2003 - The *Full RFI Report* was submitted which documented the results of the additional investigation in Section A.4.19 of Appendix A.
 - January 21, 2005 – Chevron received USEPA/NJDEP comments on the *Full RFI Report*.

6.71 Comment 71**RFI Section: 8****Comment Letter Page: 11**

In several instances, it appears that hydropunch and monitor well results are not comparable. In particular, the Department is concerned that the concentrations of volatile organic compounds in ground water samples retrieved via hydropunch or geoprobe methods are generally greater (and in some instances much greater) than in samples retrieved via monitor wells. Chevron shall perform an evaluation of ground water sampling results at several representative locations where both monitor well and hydropunch/geoprobe type results are available. Chevron shall present a map showing the locations of the samples that are evaluated. Chevron shall present a table showing: monitor well construction details (including the elevation of both the top and bottom of the screened interval), geoprobe/hydropunch screened interval, monitor well sampling method and pump placement, geoprobe/hydropunch sampling method (grab, pump, etc.), water table elevation, and ground water sample concentrations from each method. At areas where it appears that the concentration of benzene contamination may be stratified within a monitor well's screened interval, Chevron shall propose to collect ground water samples from discreet depth intervals via passive diffusion bags or other depth discrete method.

Chevron Response

Chevron acknowledges that there are numerous sites at the Perth Amboy, NJ facility in which temporary well data is not comparable to monitoring well data subsequently placed in the same or very near the same location. Temporary well points are used on site as a quick screening tool to aid in the delineation of COCs and placement of permanent monitoring wells. There are several overarching factors in the construction of temporary well points that may cause samples collected from them to be biased high for various COCs:

- Permanent monitoring wells are developed prior to sampling to remove any sediment and stagnant groundwater. This ensures that there will be no cross-contamination due to sediment infiltration during well construction, and that samples collected will contain representative groundwater from the surrounding formation. In addition, permanent monitoring wells are purged prior to each sampling event to ensure that a representative sample is collected (see Comment 40). Temporary wells are not developed or purged in this manner. Contamination can be introduced from the surface or the strata above the screen interval during drilling activities or at any time prior to sampling.
- Temporary wells are abandoned within 48 hours. There is no opportunity to collect multiple samples over time to confirm or refute whether an initial sample is representative.

- Permanent monitoring wells are packed with sand. This is especially important around the screen interval, where the sand filters solids from groundwater as it enters the well. Temporary wells are not packed with sand, allowing for greater turbidity in samples.
- Permanent monitoring wells are sealed with bentonite, and have water-tight locked caps. This ensures that the well is free of surface infiltration and influence. Runoff, contaminated surface soils, or other contaminants can enter a temporary well during drilling, or at any time prior to sampling.
- In some cases, a significant amount of time passes between the sampling of a temporary well and the installation and sampling of a monitoring well, which decreases the comparability of data collected from the two points.

Chevron expects a level of disparity between temporary wells and permanent monitoring wells for the reasons listed above. Chevron uses temporary wells as a screening tool to provide a supportive level of data for the site investigation while keeping in mind that samples collected from them can easily be biased high. This bias contributes to a conservative approach of COC delineation. A discussion follows of various locations where such inconsistencies have occurred.

H0543 and MW-0090

Temporary well H0543 and monitoring well MW-0090 are located at AOC 31, in Tank Basin 772 of the EY (Figure 37). MW-0090 was placed just east of Tank 772, with H0543 to the immediate northeast. Comment 104 hypothesizes that the smaller screen interval of temporary well points may result in higher contaminant concentrations than the larger screen interval of a monitoring well due to dilution. However, both H0543 and MW-0090 were constructed with a 10 foot screen interval. Based on the lithologic descriptions for each of these borings, the screens appropriately encompass those intervals with evidence of contamination (OVM readings, staining, odor, etc.).

At first glance, it appears that there is a large disparity between the benzene data from temporary well point H0543 (12,000 µg/L) and MW-0090. When the RFI Report was submitted, only two rounds of sampling had been completed at MW-0090 (benzene concentrations of 3,600 µg/L and 6,300 µg/L respectively). However, eight additional rounds of samples have been collected from MW-0090 (see Table 51) since then, with a range of benzene concentrations from 2,500 µg/L to 13,000 µg/L. This range encompasses the 12,000 µg/L value initially seen at H0543.

HP-0083 and MW-125

Temporary well point HP-0083 and MW-125 are located in Tank Basin 306 of the MY (see Figure 37). Both points were placed in almost the same location just northeast of Tank 306. Based on the lithologic descriptions for each of these borings, the screens appropriately encompass those intervals with evidence of contamination (OVM readings, staining, odor, etc.).

Table 51. H0543 vs. MW-0090

	H0543	MW-0090										
Date of Construction	6/27/00	1/8/02										
Screen Interval (ft bgs)	2.0-12.0	2.0-12.0										
TOS Elev (ft)	No Data	8.6										
BOS Elev (ft)	No Data	-1.4										
Sample Method	Bailer (No Purging)	3 Volume Purge/Bailer										
Pump Placement	N/A	Middle of Water Column										
GW Elev. (ft bgs)	5.0	5.0										
Sample Date	6/28/00	3/12/03	5/13/03	7/18/03	11/19/03	8/26/04	3/3/05	8/23/05	3/21/06	9/26/06	3/30/07	
Benzene Conc. (µg/L)	12,000	3,600	6,300	8,600	10,000	11,000	2,500	12,000	12,000	13,000	9,200	
PID Readings (in soil)	5.0'-6.0'	475 ppm		4.5'				100 ppm				
	6.0'-7.0'	202 ppm		5.0'				417 ppm				
	7.0'-8.0'	218 ppm		5.5'				509 ppm				
				6.5'				710 ppm				
				7.0'				423 ppm				
				7.5'				200 ppm				
				9.0'				142 ppm				
Significant Soil Boring Notes	4.5'-5.5'	Black staining.		4.0'-10.0' Soil had "sheen".								
	5.0'-5.25'	Black fly ash, wet w/petroleum odor.										
	5.25'-8.0'	Odor.										

A benzene concentration of 4,200 µg/L was measured at HP-0083. During the RFI investigation, benzene concentrations of 800 µg/L and 19 µg/L were measured at MW-125. Eight subsequent rounds of samples from MW-125 contained benzene concentrations ranging from 14 µg/L to 770 µg/L (see Table 52). None of these values approach the 4,200 µg/L found at HP-0083. However, samples from other temporary well points within Tank Basin 306 (HP-0082, H0328, H0835, and H0445) contained benzene concentrations of 240 µg/L or lower, which is much more consistent with the values observed in MW-125 than those from HP-0083.

HP-0104 and MW-131

Temporary well point HP-0104 and MW-131 are located in Tank Basin 771 of the EY (Figure 37). Both points were placed in almost the same location just west of Tank 771, with MW-131 slightly north of HP-0104. Both have 10 foot screen intervals, so dilution should not be a factor in comparing sample concentrations. Based on the lithologic descriptions for each of these borings, the screens appropriately encompass those intervals with evidence of contamination (OVM readings, staining, odor, etc.).

A benzene concentration of 3,500 µg/L was measured at HP-0104. During the RFI investigation, benzene concentrations of 180 µg/L, 490 µg/L, and 870 µg/L were measured in samples from MW-131. Benzene concentrations in 10 subsequent rounds of samples from MW-131 ranged from 120 µg/L to 1,100 µg/L (see Table 53). Again, none of the values observed in MW-131 samples compare with the 3,500 µg/L observed in HP-0104. However, samples collected from downgradient temporary well points (HP-0037, HP-0039, HP-0056, HP-0058, and HP-0059) and upgradient temporary well points (HP-0040 and HP-0060) contained much lower concentrations of benzene, more consistent with values observed at MW-131 than HP-0104.

H0303 and MW-133

Temporary well H0303 and monitoring well MW-133 are located in the southern portion of the MY just north of former Tank Basins 1 and 2 (see Figure 37). Both points were placed in almost the same location, with H0303 slightly north of MW-133. Both have 10 foot screen intervals, so dilution should not be a factor in comparing sample concentrations. Based on the lithologic descriptions for each of these borings, the screens appropriately encompass those intervals with evidence of contamination (OVM readings, staining, odor, etc.).

A benzene concentration of 860 µg/L was measured at H0303. During the RFI investigation, a benzene concentration of 2J µg/L was measured in a sample from MW-133. Benzene concentrations in six subsequent rounds of samples from MW-133 were all below the MDL (see Table 54). None of the values observed in MW-133 are comparable to the 860 µg/L observed in H0303. However, samples collected in upgradient (H0131) and downgradient (H0856 and H0902) temporary well points were all very low, and more consistent with those values observed in MW-133 than H0303.

Table 52. HP-0083 vs. MW-125

	HP-0083	MW-125									
Date of Construction	8/20/97	7/29/02									
Screen Interval (ft bgs)	3.0-8.0	1.5-11.5									
TOS Elev (ft)	No Data	5.6									
BOS Elev (ft)	No Data	-4.4									
Sample Method	Bailer (No Purging)	3 Volume Purge/Bailer									
Pump Placement	N/A	Middle of Water Column									
GW Elev. (ft bgs)	3.0	5.0									
Sample Date	8/20/97	11/22/02	2/25/03	9/17/03	3/10/04	10/6/04	6/8/05	11/8/05	6/9/06	11/21/06	6/7/06
Benzene Conc. (µg/L)	4,200	800	19	37	14	110	17	84	290	770	19
PID Readings (in soil)	High 400 ppm	4.0' 92 ppm 7.0' 201 ppm 8.0' 90 ppm									
Significant Soil Boring Notes	2.0'-4.0' Black staining. 6.0'-8.0' Black stained gravel, organic peat and clay w/black staining.	2.0'-3.0' LNAPL odor. 4.0'-5.0' LNAPL stain. 6.0'-7.0' Loose, moist, black LNAPL.									

Table 53. HP-0104 vs. MW-131

	HP-0104	MW-131													
Construction Date	9/9/97	8/15/02													
Screen Interval (ft bgs)	4.0-14.0	2.0-12.0													
TOS Elev (ft)	No Data	11.8													
BOS Elev (ft)	No Data	1.8													
Sample Method	Bailer (No Purging)	3 Volume Purge/Bailer													
Pump Placement	N/A	Middle of Water Column													
GW Elev. (ft bgs)	4.5	8.0													
Sample Date	9/9/97	10/8/02	11/14/02	1/28/03	4/30/03	6/20/03	11/7/03	8/12/04	11/30/04	3/8/05	9/15/05	3/14/06	9/12/06	4/18/07	
Benzene Conc. (µg/L)	3,500	180	490	870	1,100	630	530	820	200	810	120	280	350	280	
PID Readings (in soil)	High 125 ppm	3.0' 350 ppm 4.0' 140 ppm 7.0' 126 ppm													
Significant Soil Boring Notes	2.0'-4.0' Trace gray to black staining. 6.0'-8.0' Slight staining. 8.0'-10.0' Dark gray staining.	4.5' Product-like odor.													

Table 54. H0303 vs. MW-133

	H0303	MW-133						
Construction Date	8/9/99	8/28/02						
Screen Interval (ft bgs)	2.0-12.0	4.0-14.0						
TOS Elevation (ft)	No Data	8.72						
BOS Elevation (ft)	No Data	-1.28						
Sampling Method	Bailer (No Purging)	3 Volume Purge/Bailer						
Pump Placement	N/A	Middle of Water Column						
GW Elev. (ft bgs)	3.50	7.00						
Sample Date	8/11/99	10/17/02	10/7/04	6/1/05	11/15/05	6/15/06	11/21/06	6/12/07
Benzene Conc. (µg/L)	860	2J	0.5U	0.5U	0.5U	0.5U	3U	0.5U
PID Readings (in soil)	3.0'-4.0' 180.5 ppm 8.0' 140.3 ppm	4.0' 188 ppm 5.0' 160 ppm 5.5' 132 ppm 6.0' 223 ppm 6.5' 107 ppm 7.0' 201 ppm						
Significant Soil Boring Notes	3.5' Hydrocarbon odor. 3.5'-4.0' Dark brown staining 6.0'-7.0' Dark brown globules of dark brown to black liquid, hydrocarbon odor. 7.0'-8.0' Hydrocarbon odor, MnO ₂ stain. 9.0'-11.0' Hydrocarbon odor.	2.5'-5.0' Product-like odor. 5.0' Catalyst beads.						

H0198 and MW-135

Temporary well H0198 and monitoring well MW-135 are located in the former Bulk Station area immediately east of the MY (see Figure 37). Both points were placed adjacent to State Street, with H0198 slightly to the northeast of MW-135. Based on the lithologic descriptions for each of these borings, the screens appropriately encompass those intervals with evidence of contamination (OVM readings, staining, odor, etc.).

A benzene concentration of 4,500 µg/L was measured in a sample from H0198. During the RFI investigation, benzene concentrations of 3J µg/L and 38 µg/L were observed in samples from MW-135. Benzene concentrations in eight subsequent sampling rounds at MW-135 ranged from 5J µg/L to 110 µg/L (see Table 55). None of the values observed in MW-135 were comparable to the 4,500 µg/L observed in H0198. However, a sample collected from HP-0018, immediately adjacent to H0198 contained a benzene concentration of only 2 µg/L, which is much more consistent with the MW-135 benzene values than those at H0198.

The former Bulk Station area has received a high volume of vehicle traffic in the past. It is possible that an isolated gasoline spill from a vehicle or piece of work equipment could have resulted in the elevated benzene value observed in H0198. It is also likely that a vehicle spill from adjacent State Street could have contributed to the COCs in this area. The same phenomenon is observed in our analysis of isolated elevated MTBE concentrations in the former Bulk Station area (please see Comment 78). If this is the case, the benzene contamination does not constitute an ongoing source from Chevron.

H0238 and MW-137

Temporary well H0238 and monitoring well MW-137 are located in the central portion of the MY (see Figure 37). Both points were placed in almost the same location, with H0238 slightly north of MW-137. Both have 10 foot screen intervals, so dilution should not be a factor when comparing sample concentrations. Based on the lithologic descriptions for each of these borings, the screens appropriately encompass those intervals with evidence of contamination (OVM readings, staining, odor, etc.).

A benzene concentration of 280 µg/L was measured at H0238. During the RFI investigation, benzene concentrations of non-detect and 0.6J µg/L were measured in samples from MW-137. Benzene concentrations in seven subsequent rounds of samples from MW-137 ranged from non-detect to 0.5J µg/L (see Table 56). None of the values observed in MW-137 are comparable to the 280 µg/L observed in H0238.

Benzene concentrations in samples collected in upgradient (HP-0112, H0219, H0897, and H0898) and downgradient (HP-0120, and H0236) temporary wells were all very low, and more consistent with those values observed in MW-137 than those from H0238.

Table 55. H0198 vs. MW-135

	H0198	MW-135									
Construction Date	1/20/99	8/16/02									
Screen Interval (ft bgs)	0.0-6.0	3.0-13.0									
TOS Elev (ft)	No Data	5.7									
BOS Elev (ft)	No Data	-4.3									
Sample Method	Bailer (No Purging)	3 Volume Purge/Bailer									
Pump Placement	N/A	Middle of Water Column									
GW Elev. (ft bgs)	1.0	4.0									
Sample Date	1/21/99	10/3/02	1/22/03	7/16/03	9/24/03	8/5/04	3/10/05	8/11/05	3/7/06	9/1/06	3/13/07
Benzene Conc. (µg/L)	4,500	3J	38	21	8	20	110	10	91	5J	66
PID Readings (in soil)	0.0'-2.0' 28 ppm 5.0'-6.0' 55 ppm	<1.0' 648 ppm 2.0' 51 ppm									
Significant Soil Boring Notes	Top 6.0" Gas-like hydrocarbon odor. 0.0'-2.0' Some green staining. 5.0'-6.0' Black, hydrocarbon odor throughout, sheen on soil surface.	0.0'-2.0' Course gravel cuttings. 10.0'-14.0' Peat.									

Table 56. H0238 vs. MW-137

	H0238	MW-137									
Construction Date	6/29/99	8/27/02									
Screen Interval (ft bgs)	2.0-12.0	2.0-12.0									
TOS Elev (ft)	No Data	11.84									
BOS Elev (ft)	No Data	1.84									
Sample Method	Bailer (No Purging)	3 Volume Purge/Bailer									
Pump Placement	N/A	Middle of Water Column									
GW Elev. (ft bgs)	8.0	4.0									
Sample Date	7/2/99	10/23/02	2/27/03	9/4/03	9/24/04	5/26/05	11/1/05	5/31/06	11/17/06	6/8/07	
Benzene Conc. (µg/L)	280	0.5U	0.6J	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5J	
PID Readings (in soil)	7.5' 166 ppm 11.5' 264 ppm	<1 ppm throughout boring.									
Significant Soil Boring Notes	10.0'-12.0' Black, thick viscous liquid. 10.0'-14.0' Black fly ash w/viscous liquid and hydrocarbon odor.	12.0'-12.2' Clay w/black staining and petroleum odor.									

H0477 and MW-157

Temporary well H0477 and monitoring well MW-157 are located in Tank Basin 752 of the EY (see Figure 37). Both points were placed to the east of Tank 752, with MW-157 slightly further southeast than H0477. H0477 has a 10 foot screen interval, whereas MW-157 has a six foot screen interval, so dilution of the monitoring well sample should not be a factor when comparing sample concentrations. Based on the lithologic descriptions for each of these borings, the screens appropriately encompass those intervals with evidence of contamination (OVM readings, staining, odor, etc.).

A benzene concentration of 8,200 µg/L was measured at H0477. During the RFI investigation, a benzene concentration of 4J µg/L was measured in a sample from MW-157. Benzene concentrations in eight subsequent rounds of samples from MW-157 ranged from non-detect to 5J µg/L (see Table 57). None of the values observed in MW-157 are comparable to the 8,200 µg/L observed in H0477. However, samples collected in upgradient (H0365, H0366, H0369, H0370, and H0889) temporary well points were all very low, and more consistent with those values observed in MW-157 than H0477. In addition, H0477 is screened from 0 to 10.0 ft. bgs, increasing the possibility that surface contamination could have biased sample concentrations high.

HP-0100 and RW-42

Temporary well HP-0100 and monitoring well RW-42 are located in the eastern portion of the MY (see Figure 37). Both points were placed in almost the same location, with HP-0100 slightly south of RW-42. Both have comparable screen intervals, so dilution should not be a factor when comparing sample concentrations. Based on the lithologic descriptions for each of these borings, the screens appropriately encompass those intervals with evidence of contamination (OVM readings, staining, odor, etc.).

A benzene concentration of 11,000 µg/L was measured at HP-0100. During the RFI investigation, a benzene concentration of 2J µg/L was measured in a sample from RW-42. Benzene concentrations in six subsequent rounds of samples from RW-42 ranged from non-detect to 220 µg/L (see Table 58). None of the values observed in RW-42 are comparable to the 11,000 µg/L observed in HP-0100. However, samples collected in downgradient (HP-0035 and H0465) temporary wells were all very low, and more consistent with those values observed in RW-42 than HP-0100.

In addition, field workers noted significant quantities of free phase product on the sample collection device at HP-0100. It is possible that this product contaminated the VOC sample collected at this boring.

In summary, there are various plausible explanations to support Chevron's claim that monitoring well data is more reliable than temporary well data, including differences in sampling protocols, construction methods, comparison to data collected from adjacent sample points, and cross-contamination.

Table 57. H0477 vs. MW-157

	H0477	MW-157								
Construction Date	11/12/99	9/5/02								
Screen Interval (ft bgs)	0-10	2-8								
TOS Elev (ft)	No Data	16								
BOS Elev (ft)	No Data	10								
Sample Method	Bailer (No Purging)	3 Volume Purge/Bailer								
Pump Placement	N/A	Middle of Water Column								
GW Elev. (ft bgs)	2.5	2.6								
Sample Date	11/12/99	5/12/03	7/31/03	11/25/03	8/25/04	4/14/05	9/15/05	4/6/06	9/26/06	4/26/07
Benzene Conc. (µg/L)	8,200	4J	5J	0.5U	2J	1J	4J	0.5U	2J	0.6J
PID Readings (in soil)	2' 1,100 ppm 3' 2495 ppm 6' 676 ppm 7' 470 ppm	5' 80 ppm 6' 14 ppm								
Significant Soil Boring Notes	1'-4' Hydrocarbon odor. 5'-7' Black liquid throughout. 8'-10' Hydrocarbon odor.	4'-5' LNAPL film on soil. 5'-6' Trace LNAPL.								

Table 58. HP-0100 vs. RW-42

	HP-0100	RW-42						
Construction Date	9/5/97	5/29/01						
Screen Interval (ft bgs)	4-14	1-10						
TOS Elev (ft)	No Data	11.1						
BOS Elev (ft)	No Data	2.1						
Sample Method	Bailer (No Purging)	3 Volume Purge/Bailer						
Pump Placement	N/A	Middle of Water Column						
GW Elev. (ft bgs)	5	4						
Sample Date	9/5/97	11/4/02	9/29/04	6/1/05	11/16/05	6/15/06	12/7/06	6/12/07
Benzene Conc. (µg/L)	11,000	2J	0.5U	90	200	220	92	3J
PID Readings (in soil)	High 85 ppm	6.5' 250 ppm 7.5' 362 ppm 8.5' 702 ppm						
Significant Soil Boring Notes	0'-2' Black staining, petroleum odor. 2'-4' Heavy petroleum odor, staining. 4'-8' Petroleum odor, staining. Product noted on sampling tool and interface probe.	2'-6' - Staining. 6'-10' - Saturated with black liquid.						

Chevron believes that the data from the permanent monitoring wells adequately characterizes groundwater quality at this site. Chevron does not currently recommend the use of passive diffusion bag samplers (PDBSs) at the Perth Amboy, NJ site as suggested in Comment 71 above for several reasons:

- PDBSs are not recommended for use at sites where MTBE has been detected. Detections of MTBE are intermittently noted at various monitoring wells on site.
- PDBSs are not recommended for use at sites exhibiting free product or high contaminant concentrations. Various wells on-site contain free product and require evacuation of free phase liquid prior to sampling. In addition, VOC concentrations have been detected in the thousands to tens of thousands ppb range at certain wells.
- It may be difficult with PDBSs to acquire enough sample volume for multiple parameters or QC samples. Chevron makes a practice of collecting QC samples according to NJDEP guidelines, and in addition to VOCs, Chevron collects groundwater samples for SVOCs, ammonia, metals, and natural attenuation parameters at many wells. These analyses sometimes require large volumes of sample to complete.
- PDBSs are not recommended for monitoring natural attenuation or stabilization. Chevron makes a practice of monitoring geophysical parameters such as pH, dissolved oxygen, and oxidation reduction potential until they stabilize, prior to collecting metals samples. In addition, Chevron monitors numerous wells on site for natural attenuation parameters. PDBSs would preclude much of this sampling.

6.72 Comment 72**RFI Section: 8.1.2, page 251, #5****Comment Letter Page: 11**

Chevron states "the data show a ridge of groundwater trending east-west through the central portion of the East Yard. This ridge is due to perched water on Clay Horizon A and till deposits". Chevron shall determine the cause of ground water depression found between MW-173 and MW-146 (as depicted on figure 8-1). Chevron shall clarify whether this is ground water from the shallow fill aquifer discharging to a deeper aquifer in this area or are subsurface piping and utilities the discharge point for ground water in this area.

Chevron Response

Chevron believes that the groundwater "depression" in the vicinity of MW-146 and MW-173 is due to the type of fill present in these areas. MW-146 and MW-173 appear to contain more coarse grain materials than MW-145 as can be seen on cross section A-A' (Figure 8-2, RFI Report 2003).

Based upon an analysis of the groundwater gauging data between shallow monitoring well MW-131 and recently installed deep monitoring well MW-246, a downward gradient exists between the first water-bearing zone in the fill material, and the first water-bearing zone in the native material. In addition, a similar vertical gradient is observed between nearby shallow monitoring well MW-228 and deep monitoring well MW-247. However, analytical data collected from MW-246 and MW-247 indicates that no VOCs or SVOCs are present in concentrations exceeding the SRFI Evaluation Criteria in the deep zone. Therefore, although a vertical gradient is observed between the first water-bearing zone in the fill material and the first water-bearing zone in the native material, no evidence of contaminant migration between these two water-bearing zones exists in this vicinity. Please refer to Comment 2 for further information.

6.73 Comment 73**RFI Section: 8.1.2, page 251, last #****Comment Letter Page: 11**

Chevron indicates that Woodward Clyde Associates performed falling head slug tests in 1982. Chevron shall include the data and analyses for these tests as an appendix to the RFI report.

Chevron Response

The falling head and slug test data are presented in Table 59 below.

Table 59. In-Situ Horizontal Permeability Test Results¹

Boring No.	Test Type	K (ft/yr)	K (cm/s)
SB-10	FH	4	4×10^{-6}
SB-11	FH	39.4	4×10^{-5}
SB-12	NS ²	NS ²	NS ²
SB-13A	S	44	4×10^{-5}
SB-13B	FH	4	4×10^{-6}
DMS-5	FH	22	4×10^{-5}

FH = Falling Head Test

S = Slug Test

NS = Not Sampled

¹Data taken from Table 5 of Woodward-Clyde Consultants' report *Phase II Hydrogeologic Report Chevron Perth Amboy Refinery* (1982).

²Not sampled, well damaged.

6.74 Comment 74**RFI Section: 8.1.2, page 252, #2****Comment Letter Page: 11**

Chevron indicates that laboratory Shelby tube tests were conducted for the till layer by Woodward Clyde. The data and analyses for these tests shall be submitted as an appendix to the RFI report.

Chevron Response

The Shelby tube test data are presented in Table 60 below.

Table 60. Laboratory Analysis of Soil Samples¹

Sample No.	Depth (ft)	USCS ²	Water Content (%)	LL (%)	PL (%)	Sieve 200 (%)	pcf	Vertical Perm.
SB-12								
S-5	8-10	SM	13.0			22.9		
T-1	14-16						95.8	
T-1C	15.3	OH	76.3	103.0	44.0	98.0	95.9	6.9x10 ⁻⁸
S-8	20-22	CH-OH	83.9	103.0	37.0	99.4		
SB-13A								
US-2	22-24						97.4	
US-2B	23.8	OH	85.9	97.0	43.0	99.4	94.1	6.1x10 ⁻⁸
S-11	24-26	CH-OH	62.2	83.0	30.0	64.7		
S-14	40-42	SC	10.9			39.4		

¹Data taken from Table 4 of Woodward-Clyde Consultants' report (1982).

²Unified Soil Classification System

LL = Liquid Limit

PL = Plastic Limit

pcf = Percent Fines

6.75 Comment 75**RFI Section: 8.1.2, page 252, #2****Comment Letter Page: 11**

In addition to the discussion concerning horizontal gradients and transport, Chevron must submit a discussion concerning vertical gradients and vertical contaminant migration. This shall include a discussion of the adequacy of the current ground water monitoring network for detecting vertical migration of contaminants.

Chevron Response

See Comment 2 response.

6.76 Comment 76**RFI Section: 8.1.2, page 254, #1****Comment Letter Page: 11**

Chevron indicates that the presence of nitrosodiphenylamine in MW-152 needs to be confirmed through additional sampling. The Department concurs with this proposal. Chevron further states that this chemical will not be further evaluated. The NJDEP cannot concur. First, as originally proposed, Chevron shall confirm the presence of nitrosodiphenylamine in MW-152. If it is determined that the compound is not present, then further evaluation will not be required.

Chevron Response

Section 8.1.2, page 254 of the RFI Report references n-nitrosodiphenylamine in MW-129, not MW-152 as written in Comment 76. Accordingly, the comment response that follows addresses MW-129.

MW-129 (installed in a part of the Refinery called the Elevated Parking Lot) has been sampled 13 times between October 2002 and August, 2006 (see Table 61). N-nitrosodiphenylamine was detected in all but one of these sampling events at concentrations ranging from non-detect to 80 µg/L. There is no obvious or discernible pattern to the change over time in n-nitrosodiphenylamine concentrations in groundwater samples collected from MW-129.

Table 61. Ground water N-nitrosodiphenylamine Concentrations in MW-129

Sample Date	N-nitrosodiphenylamine (µg/L)
10/14/02	73
1/29/03	35
11/19/03	50
2/25/04	27
7/21/04	80
10/14/04	59
1/11/05	38
5/17/05	51
7/28/05	56
12/14/05	38
2/24/06	32
6/6/06	2U
8/17/06	47

N-nitrosodiphenylamine is a rubberizing agent that was used primarily in the production of tires and other materials. Its first reported use was in 1950 with production ending in 1981 (U.S. International Trade Commission, 1995).

Despite the continued presence of n-nitrosodiphenylamine in groundwater from MW-129, Chevron feels no additional site characterization or investigation is necessary at this location for the following reasons:

- N-nitrosodiphenylamine is a material that has not been used or manufactured at the Refinery. It has not been detected in soil samples from the Elevated Parking Lot or in soil or groundwater samples from other areas of the site (see Table 62).
- MW-129 is in the southeastern corner of the Elevated Parking Lot and based on groundwater flow patterns (see Figure 33), it is likely that the source of the n-nitrosodiphenylamine is to the south-southeast of the property (i.e., not on the Chevron site). Reviews of air photos, Sanborn Maps and other historical data sources demonstrate that Chevron (and its predecessor companies) did not own or operate on property upgradient (south-southeast) of the Elevated Parking Lot.
- It can be argued that portions of Chevron's CY are upgradient of MW-129. However, none of the monitoring wells currently located in the CY have exhibited detections of n-nitrosodiphenylamine.

Table 62. N-nitrosodiphenylamine in Soil - Elevated Parking Lot

Sample No.	Sample Depth (ft. bgs)	N-nitrosodiphenylamine (mg/kg)
S1872	1.0-1.5	ND
S1873	9.0-9.5	ND
S1874	7.0-7.5	ND
S1875	3.0-3.5	ND
S1876	4.0-4.5	ND
S1877	4.0-4.5	ND
S1878	3.5-4.0	ND
S1879	4.0-5.0	ND
S1880	7.5-8.0	ND

Note: Soil samples collected during Geoprobe boring program on June 25, 2004.

6.77 Comment 77

RFI Section: 8.1.2, page 254, #3

Comment Letter Page: 11

Chevron indicates that iron, manganese and aluminum will not be included in further evaluations in the East Yard. This proposal is acceptable to the Department.

Chevron Response

Chevron acknowledges NJDEP's comment.

6.78 Comment 78**RFI Section: 8.1.2, page 259, last #****Comment Letter Page: 11**

Chevron states "methyl tert-butyl ether (MTBE) was detected at 71 µg/L in MW-135. This compound was never used at the Refinery and its presence must be attributable to other sources". The Department notes that MTBE is a gasoline additive and its presence at a refinery would not be unexpected. Chevron should submit additional information to support their claim that MTBE is not site related. In addition, if Chevron is claiming that the MTBE is from an off-site source, then a background ground water investigation is required pursuant to the Department's technical requirements.

Chevron Response

Chevron reasserts that MTBE was not used at the Chevron Perth Amboy Refinery. Production of gasoline was terminated at the Refinery in 1983 prior to the general use of MTBE as an additive. Subsequent to this, gasoline containing MTBE was not terminated at the Refinery. It is possible that an isolated surface spill from a vehicle or other piece of equipment using gasoline with MTBE may have occurred at various locations throughout the site. However, any detections of MTBE in on-site monitoring wells as a result of this do not constitute an ongoing source of contamination. Chevron believes the limited detections of MTBE at the Refinery support this claim.

Small detections of MTBE (generally less than 10 µg/L) have occurred in monitoring wells at various locations throughout the facility. However, exceedances of the NJDEP GWQS for MTBE (70 µg/L) have only occurred at MW-117 and MW-226 in addition to MW-135 (see Table 63 through Table 65).

Table 63. MTBE Concentrations in MW-135.

MW-135 Sampling Date	MTBE (µg/L)
10/3/02	41
1/22/03	71
7/16/03	76
9/24/03	67
8/5/04	73
3/10/05	76
8/11/05	64
3/7/06	85
9/1/06	36
3/13/07	53

Table 64. MTBE Concentrations in MW-117.

MW-117 Sampling Date	MTBE (µg/L)
11/22/02	240
2/27/03	220
9/12/03	170
3/2/04	130
10/6/04	190
6/8/05	100
11/8/05	140
6/1/06	160
11/21/06	160

Table 65. MTBE Concentrations in MW-226.

MW-226 Sampling Date	MTBE (µg/L)
11/23/05	300
12/8/05	370
3/2/06	270
5/18/06	230
8/22/06	140

MW-135 is located in the former Bulk Station area adjacent to State Street. It is most probable that runoff from a gasoline spill on State Street or in the Bulk Station is the source of the MTBE at this location.

MW-117 is located in Tank Basin 301 in the NF Area. Tank 301 and the surrounding Tanks (300, 326, and 327) have been historically used for gasoline storage. However, as discussed previously, no gasoline containing MTBE has ever been processed at the Perth Amboy, NJ facility. MW-117 is not immediately adjacent to any high traffic areas that could account for a release. However, vehicles used for maintenance and operations are most probably the source of the MTBE in this area. No other monitoring wells in the vicinity exhibit MTBE exceedances (see Comment 100).

MW-226 is located on the Dave's Trucking property east of the CY and west of State Street. This property was included in the AOC 36 Chlorinated Plume Investigation. The Dave's Trucking property, as well as the Celauro property immediately south of it have historically been used to stage and repair vehicles. It is probable that the MTBE release occurred on one of these properties, and does not originate from the Chevron property.

As demonstrated in Table 63 through Table 65, Chevron has continued to monitor these wells for MTBE since submittal of the RFI Report. Chevron plans to continue to monitor for MTBE in these wells on at least an annual basis in the future. It is believed that this strategy will provide sufficient information about MTBE in these isolated instances.

6.79 Comment 79

RFI Section: 8.1.4.1, Figure 8-6

Comment Letter Page: 12

Chevron shall determine the cause of the disparity between ground water samples collected at H0198 (benzene 4,500 J µg/L) and MW-135 (benzene 3 µg/L).

Chevron Response

See response to Comment 71.

6.80 Comment 80**RFI Section: 8.1.4.1****Comment Letter Page: 12**

Chevron should note that additional delineation of ground water contamination at the Loading Rack area (AOC 21) is required. According to Figure 8-1 (East Yard GW Contours) MW-0043 does not appear to be directly downgradient from H0198. Chevron shall collect additional ground water samples from the area between MW-0043 and HP0019 (at the intersection of State St. and the Chevron/Hess property boundary).

Chevron Response

According to the latest groundwater contour map (see Figure 37), groundwater flow through AOC 21 moves east toward MW-0043. MW-0043 has been sampled 16 times since it was installed in 1998. No VOCs have ever been detected in excess of the SRFI Evaluation Criteria. Therefore, MW-0043 provides sufficient control and delineation of VOC contamination for AOC 21 downgradient of H0198. In addition, the data visualization model of benzene in groundwater shows that there is sufficient control and delineation of the contaminant plume at AOC 21. Analytical data for groundwater samples collected at MW-0043 are included in Appendix G.

6.81 Comment 81

RFI Section: 8.1.4.1

Comment Letter Page: 12

Chevron shall delineate the contamination found in monitor well MW-0035 (benzene 90 J $\mu\text{g/L}$).

Chevron Response

Please see Comment 80.

6.82 Comment 82**RFI Section: 8.1.4.2, Figure 8-6****Comment Letter Page: 12**

Chevron shall collect additional ground water samples upgradient from sample HP-0044 (the sample location number is illegible on figure 8-6 the sample is located between samples H0514 and HP-0059). Additional sampling is required upgradient from this area to confirm that the source area has been effectively delineated.

Chevron Response

As stated in Comment 63, since the original RFI, Chevron has installed five additional shallow permanent monitoring wells (MW-208, MW-209, MW-227, MW-228, and MW-229) in the vicinity of SWMU 42 between 2004 and 2005. In addition, two temporary wells (H1001 and H1002) and two shallow permanent monitoring wells (MW-236 and MW-245) in AOI 1 were installed in this area during the SRFI in 2006 (see Section 5.4.1). Most recently, in 2007, one shallow permanent monitoring well (MW-272) was installed at SWMU 42 during the CMS. Most of these wells (seven of eight) are upgradient of historical temporary well HP-0044 and are depicted on Figure 37. Figure 37 depicts the extent of benzene in groundwater based on 2007 groundwater sampling data and historical temporary well groundwater data. Upon examination of the delineation of benzene in groundwater in the vicinity of HP-0044, it is evident that the historical source area is AOC 27 (Tank 777 Pipeway) and not SWMU 42 (Crude Slab) located upgradient (see Figure 37).

Based on Figure 37, Chevron believes there are an adequate number of monitoring wells in this area to delineate benzene in groundwater. Chevron will continue to monitor these wells and report the findings to EPA and NJDEP.

6.83 Comment 83**RFI Section: 8.1.4.2, page 266, #1****Comment Letter Page: 12**

Chevron proposes to assess remedial options for the TEL burials in this area during the CMS. The NJDEP concurs. Chevron shall also evaluate remedial options for the dissolved contaminant plume during the CMS.

Chevron Response

Chevron agrees and will address these concerns during the CMS.

6.84 Comment 84**RFI Section: 8.1.4.2, page 266, #2****Comment Letter Page: 12**

Chevron proposes to monitor seven wells (MW-145, MW-152, MW-146, MW-131, MW-043, MW-173, MW-148) for a minimum of six sampling rounds. In addition, a monitor well shall be installed at the location of HP-0044. This well is required to monitor trends at the location of the highest benzene concentration found in the area.

Chevron Response

Please see Comment 63.

6.85 Comment 85**RFI Section: 8.1.4.2****Comment Letter Page: 12**

The closest proposed downgradient monitor well is 350 feet from the apparent edge of the contaminant plume. In order to effectively monitor contaminant plume trends, Chevron shall determine the location of the edge of the contaminant plume. Chevron shall install a plume fringe well at the location of the edge of the contaminant plume. Chevron shall add this new monitoring point to the proposed ground water monitoring plan.

Chevron Response

As per Section 5.4.1 (EY Area AOI 1), Chevron installed five temporary wells (H0998, H0999, H1000, H1017, and H1018) and three permanent monitoring wells (MW-235, MW-236, and MW-245) in the vicinity of AOC 27 and SWMU 10 to determine the location of the edge of the contaminant plume. These three shallow permanent wells were screened across the water table in the upper water-bearing zone in the fill as identified by the SAIC Supervisory Geologist.

During the SRFI, groundwater samples were collected from these new SRFI wells and existing nearby wells. The results of the sampling are depicted in several SRFI COC site-wide distribution maps which include arsenic, ammonia, benzene, cyclohexane, lead, and methylcyclohexane (see Figure 35 through Figure 40, respectively). Appendix G presents the laboratory analytical data for all groundwater monitoring wells, including dissolved metals concentrations, and their respective SRFI Evaluation Criteria.

Site-wide groundwater contour maps from 2003 (see Figure 32) indicate average groundwater flow direction across the entire AOI 1 Area is generally north-northeast, towards the Woodbridge Creek. The February 2007 shallow groundwater contour map (see Figure 33) confirms groundwater flow direction is generally north-northeast in this area. The average gradient across the area was calculated to be 0.008166, and average flow direction was 20.72 degrees from north, based upon data collected during the February 2007 site-wide gauging event.

Four of the five groundwater grab samples collected from the temporary wells in the AOI 1 vicinity contained concentrations of VOCs in excess of the SRFI Evaluation Criteria. Sample H0998, collected from temporary well H0998, contained benzene (29 µg/L) in excess of the SRFI Evaluation Criterion (1 µg/L), and was collected from a two foot screen interval, set three 3.0 to 5.0 ft bgs. Sample H0999 was collected from H0999, and contained concentrations of benzene (110 µg/L), cyclohexane (220 µg/L), and methylcyclohexane (140 µg/L), in excess of the SRFI Evaluation Criteria for those compounds (1 µg/L, 100 µg/L, and 100 µg/L, respectively). H0999 was located approximately 80 feet south of H0998, along the State Street property line, and the screened interval was also three 3.0 to 5.0 ft bgs. Sample H1000 contained benzene (400

µg/L) in excess of the SRFI Evaluation Criteria (1 µg/L). Temporary monitoring well H1000 was located approximately 80 feet south of H0999 and 160 feet east of Tank 777. The concentration of MTBE in sample H1018 (190 µg/L) was in excess of the SRFI Evaluation Criterion (70 µg/L). Temporary monitoring well H1018 was located approximately 200 feet south of H0999. No VOCs were detected in concentrations above the SRFI Evaluation Criteria in samples collected from temporary wells H1017.

Three new shallow, permanent, monitoring wells (MW-235, MW-236, and MW-245) were installed during the SRFI. Following groundwater gauging, a sample was collected from each of these monitoring wells and analyzed for VOCs, SVOCs, and metals. Of the three groundwater samples, only well MW-236 contained a VOC (benzene, 13 µg/L) at a concentration exceeding the SRFI Evaluation Criterion (1 µg/L). Sample M236A1 was collected from MW-236, at a depth of 6.0 to 11.0 ft. bgs. This sample also contained the only SVOC (2-methylnaphthalene, 130 µg/L) at a concentration exceeding the SRFI Evaluation Criterion (100 µg/L). There were several dissolved metals in concentrations exceeding the SRFI Evaluation Criteria for samples collected from MW-235, MW-236, and MW-245. All three monitoring wells contained concentrations of iron and manganese exceeding the SRFI Evaluation Criteria. Wells MW-235 and MW-245 contained dissolved concentrations of aluminum and lead exceeding the SRFI Evaluation Criteria. Wells MW-236 and MW-245 contained dissolved concentrations of arsenic and sodium above the SRFI Evaluation Criteria. Additionally, MW-245 contained dissolved concentrations of antimony and cobalt above the SRFI Evaluation Criteria. Appendix G presents all laboratory analytical data for the shallow monitoring wells, including dissolved metals concentrations, and their respective SRFI Evaluation Criteria.

Based on the SRFI findings, no additional wells are necessary in this area and Chevron plans to continue monitoring of the existing wells and provide updates to EPA and NJDEP quarterly.

6.86 Comment 86**RFI Section: 8.1.4.3, page 266, #3****Comment Letter Page: 12**

Chevron states, "This plume extends from the Crude Slab east to MW-141". However, the Department notes that, according to figure 8-1, ground water elevation in MW-141 is 14.09 feet while ground water elevations in the area of the Crude Slab are 10 to 12 feet. Therefore, contamination must be flowing from the Crude Slab to the northwest. This indicates that the source of the contamination in the tank basins is not the Crude Slab. Chevron shall determine the source of the ground water contamination in tank basins 750, 751 and 752.

Chevron Response

Chevron's statement that the plume extends from the Crude Slab east to MW-141 was not meant to imply that the Crude Slab is the source of groundwater contamination in this area. The Crude Slab is merely a geographic reference point used to describe the distribution of the groundwater plume.

6.87 Comment 87**RFI Section: 8.1.4.3****Comment Letter Page: 12**

The Department notes that, according to cross section figure 8-4, MW-141 is screened in a till layer while MW-143 is screened in fill over gray clay (Clay Horizon A). It may be inappropriate to contour water level maps for the East Yard. One map shall contour the apparently perched water within the fill where it is underlain by the gray clay. The other map shall contour the fill and till layers where the perching clay is absent.

Chevron Response

Chevron has reviewed the Department's request to map groundwater in this area from wells screened in the till separate from the wells screened above or in the clay. Chevron feels that since both of the zones are under water table conditions and no confining layers are evident, that the zones are in direct hydraulic communication. Therefore, mapping the wells in question separately does not appear to be necessary.

6.88 Comment 88**RFI Section: 8.1.4.3****Comment Letter Page: 12**

Based on ground water flow direction, the delineation of the dissolved phase ground water contamination plume emanating from the Crude Slab shall be re-evaluated and a revised RFI report submitted to the Department.

Chevron Response

Since the original RFI in 2003, Chevron has installed eight additional shallow wells and one deep well in the vicinity of SWMU 42 (Crude Slab) to delineate the extent of dissolved phase groundwater contamination. Five additional shallow permanent monitoring wells (MW-208, MW-209, MW-227, MW-228, and MW-229) were installed in the vicinity of SWMU 42 between 2004 and 2005. In addition, two temporary wells (H1001 and H1002) and two shallow permanent monitoring wells (MW-236 and MW-245) in AOI 1 were installed in this area during the SRFI in 2006 (see Section 5.4.1). Most recently, in 2007, one shallow permanent monitoring well (MW-272) were installed at SWMU 42 during the CMS. All of these wells are depicted on Figure 37. Figure 37 depicts the extent of benzene in groundwater based on 2007 groundwater sampling data and historical temporary well groundwater data. As such, Chevron believes there are adequate wells in the area to determine groundwater flow direction and has confirmed groundwater flow toward the northwest. Furthermore, the COC, benzene, has been delineated in the vicinity of SWMU 42 as depicted on Figure 37.

During the SRFI, two temporary wells (H1001 and H1002) were completed downgradient of the SWMU 42 area to delineate benzene in groundwater. Each temporary well was sampled and analyzed for TCL VOCs via EPA Method SW-846 8260B. No VOCs were detected in concentrations above the SRFI Evaluation Criteria in either sample from H1001 or H1002. Section 4.2.2 provides a description of how these SRFI temporary wells were constructed. None of these temporary wells were replaced with permanent monitoring wells during the SRFI. Appendix A contains the boring logs for all temporary wells.

During the SRFI, one shallow permanent monitoring well (MW-245) was installed during the SRFI downgradient of the SWMU 42 Area. Following groundwater gauging, a sample was collected from MW-245 and analyzed for VOCs, SVOCs, and metals. No VOCs or SVOCs were detected above the SRFI Evaluation Criteria. However, there were several dissolved metals in concentrations exceeding the SRFI Evaluation Criteria for samples collected from MW-245. MW-245 contained concentrations of aluminum, antimony, arsenic, cobalt, iron, lead, manganese, and sodium exceeding the SRFI Evaluation Criteria. Figure 36 and Figure 39 depict the extent of arsenic and lead contamination in groundwater in the vicinity of SWMU 42 based on this SRFI data. Appendix G presents all laboratory analytical data for the shallow monitoring wells, including dissolved metals concentrations, and their respective SRFI Evaluation Criteria.

As presented in Section 5.4.1, one deep well (MW-247) was installed in the SWMU 42 Area to examine vertical gradients and to determine vertical delineation of COCs in groundwater. This deep well (MW-247) was paired with existing shallow well MW-228 to investigate the hydrogeologic relationships between the first shallow and first native water-bearing zones across the AOI 1 Area. A downward vertical gradient of 0.01973 was calculated from shallow well MW-228 to deep well MW-247. Vertical hydraulic gradients were calculated from the February 2007 gauging data using the USEPA Site Assessment Calculations website (2007b), and are included in Appendix F. Based upon the boring logs from the MW-228 and MW-247 installations, only MW-247 intersects the peat horizon at approximately 10.0 ft. bgs. In addition, the descriptions of the sediments above and below the peat horizon vary between these two wells. Based on the discontinuity of the peat, the variance in sediments above and below the peat horizon, and the evidence of a downward vertical gradient between wells, a degree of hydraulic interconnectivity between the first shallow water-bearing zone and first native water-bearing zone in this location can be inferred.

The deep groundwater contour map generated from the February 2007 site-wide gauging data (Figure 34) indicates that groundwater flow in the SWMU 42 area is generally northeast, towards the Woodbridge Creek. Deep groundwater flow across the area occurs within the first water-bearing zone of the native material, and flows under an average gradient of 0.00675.

Following groundwater gauging of MW-247, a sample was collected and analyzed for VOCs, SVOCs, and metals. Despite evidence of hydraulic interconnectivity between water-bearing zones at MW-247, the sample contained no VOCs or SVOCs in concentrations exceeding the SRFI Evaluation Criteria. However, deep well MW-247 contained concentrations of aluminum, arsenic, total iron, manganese, and sodium exceeding the SRFI Evaluation Criteria.

In comparison, shallow well MW-228 sample data has exhibited one exceedance for benzene (3J $\mu\text{g/L}$) after two rounds of sampling. Shallow well MW-228 is not analyzed for SVOCs and metals. However, other nearby shallow wells at SWMU 42 exhibit much higher concentrations of benzene in groundwater. For example, CMS shallow well MW-272 exhibits a concentration of 9,500 $\mu\text{g/L}$ of benzene in groundwater (see Figure 37). Appendix G presents all laboratory analytical data for all the monitoring wells and their respective SRFI Evaluation Criteria.

Based on the SRFI findings, no additional wells are necessary in this area to determine horizontal and vertical delineation of contaminants. Chevron plans to continue monitoring of the existing wells and provide updates to EPA and NJDEP quarterly.

6.89 Comment 89**RFI Section: 8.1.4.4, page 267, last #****Comment Letter Page: 13**

Chevron indicates that the dissolved plume has been delineated to the east by ground water samples located at H0454 and H0464. The Department notes that, according to figure 8-1, these samples are located upgradient from the contaminant plume. Chevron indicates that the tank 772 Pump Pad contaminant plume is delineated to the west by samples at H0345 and H0456. The Department notes that (according to Figure 8-1) these samples are located sidegradient from the contaminant plume. Chevron indicates that downgradient delineation is provided by MW-9. The Department notes that, according to Figure 8-1, MW-9 is not located directly downgradient from the contaminant plume and is located 180 feet from H0544. Chevron shall determine the location of the edge of the contaminant plume. Chevron shall install plume fringe wells that delineate the extent of this contamination.

Chevron Response

During the SRFI, two additional monitoring wells (MW-250 and MW-251) were installed in the Tank 772 vicinity to vertically and horizontally delineate the dissolved phase contaminant plume in this area. SRFI well MW-250 is a deep monitoring well screened from 29.0 to 34.0 ft. bgs, and was installed to vertically delineate the dissolved phase plume. SRFI well MW-251 is a shallow monitoring well screened from 5.0 to 10.0 ft. bgs and was installed to horizontally delineate the dissolved phase plume downgradient of Tank 772 (see Figure 37 and Section 5.4.4).

During the SRFI, groundwater samples were collected from these new SRFI wells and existing nearby wells. The results of the sampling is depicted in several SRFI COC site-wide distribution maps which include arsenic, ammonia, benzene, cyclohexane, lead, and methylcyclohexane (see Figure 35 through Figure 40, respectively). Appendix G presents all laboratory analytical data for all groundwater monitoring wells, including dissolved metals concentrations, and their respective SRFI Evaluation Criteria.

Two groundwater samples, M250A1 and M250A2, were collected from MW-250 on February 16 and May 22, 2007, respectively. Both samples were analyzed for VOCs, SVOCs, and metals. Sample M250A1 contained concentrations of VOCs including benzene (180 µg/L), and bromodichloromethane (4 µg/L) in excess of the SRFI Evaluation Criteria (1 µg/L and 1 µg/L, respectively). Sample M250A2 contained concentrations of VOCs including benzene (5,800 µg/L), cyclohexane (340 µg/L), and methylcyclohexane (140 µg/L) in excess of the SRFI Evaluation Criteria (1 µg/L, 100 µg/L, and 100 µg/L, respectively). Both M250A1 and M250A2 contained arsenic, iron, manganese, and sodium in concentrations above the SRFI Evaluation Criteria. Based on all compiled analytical data for MW-250, groundwater contamination in the MW-250 vicinity is not vertically delineated, and further investigation is warranted.

On February 16, 2007, sample M251A1 was collected from MW-251 and analyzed for VOCs, SVOCs, and metals. Sample M251A1 contained no VOCs or SVOCs in concentrations exceeding the SRFI Evaluation Criteria. This sample did contain dissolved metals including aluminum, arsenic, iron, manganese, and sodium in concentrations exceeding the SRFI Evaluation Criteria. With regard to Comment 89, the VOC and SVOC analytical data from MW-251 serve to delineate the extent of contamination downgradient from Tank 772.

Chevron is currently investigating AOC 31 and installed additional monitoring wells in the Fall of 2007 to delineate COCs in groundwater. The findings of this investigation will be presented to EPA and NJDEP once formally reviewed by Chevron.

6.90 Comment 90**RFI Section: 8.1.4.5, page 269, #2****Comment Letter Page: 13**

Chevron indicates that ground water flow direction in this area is toward the east. However, as depicted on Figure 8-1, ground water flow is toward the northeast at this AOC. Additional delineation of this contamination to the north and northeast is required.

Chevron Response

Since the submittal of the RFI Report in 2003, three additional shallow wells (MW-213, MW-214, and MW-215) have been installed in the SWMU 8 Area. During the SRFI, no additional shallow wells were installed in this area and no off-site investigation was conducted to the north of SWMU 8 on the neighboring Amerada Hess Corporation (AHC) property by Chevron. AHC has been actively monitoring the groundwater downgradient of Chevron's SWMU 8 since 1996. AHC's Remedial Investigation and Groundwater Sampling Progress Reports (2002a, 2002b, and 2002c) indicate that the distribution of benzene in groundwater depicted in Figure 37 is delineated on the AHC property by AHC well MW-5 (see Appendix J).

The latest shallow groundwater contour map indicates that groundwater flow is to the north-northeast of SWMU 8 toward the property boundary (see Figure 33). The delineation of arsenic, benzene, and lead in groundwater in the vicinity of SWMU 8 is depicted in Figure 36, Figure 37, and Figure 39 respectively. These three figures indicate that these contaminants may extend to the north onto the AHC property. The extent of cyclohexane and methylcyclohexane in groundwater in this area is delineated on-site (see Figure 38 and Figure 40, respectively). Based upon the limited aerial extent of dissolved benzene, and the north-northeastward groundwater flow direction in the vicinity of Chevron's SWMU 8 wells and AHC's well MW-5 (as determined by both Chevron and AHC) dissolved groundwater contamination in the this vicinity appears to be isolated and possibly controlled by the swale located between the two properties.

During subsequent sampling of new and previously installed SWMU 8 monitoring wells, separate phase hydrocarbon (free product) was found to have accumulated on the groundwater in wells MW-132, MW-214, and MW-215. Product thickness ranged from a sheen in MW-132 to over two feet in MW-215. Samples of this product have been tested and were found to have characteristics consistent with No. 2 fuel oil. This area of the Refinery has never been associated with the production, storage, or handling of No. 2 fuel oil and its presence on the groundwater in these wells is an indication of an off-site source. Periodic product removal from MW-132, MW-214, and MW-215 has resulted in a decrease in thickness levels in these wells (please see Table 66). However, it is likely that the free product (and associated dissolved phase contamination) detected on ground water in monitoring wells along the northeastern edge of SWMU 8 originated from the AHC property at 1 State Street in Perth Amboy (Appendix J). In 1990, AHC had a No.6

fuel oil spill caused by a structural failure underneath an above ground storage tank (AHC, 2003). Further investigation of this area will be performed as part of supplemental CMS field activities.

Table 66. SWMU 8 LNAPL Thicknesses (ft)

Date	MW-132	MW-214	MW-215
01/05/06	0.00	0.00	0.00
01/17/06	0.02	0.00	0.00
01/24/06	0.00	0.00	0.00
01/31/06	0.00	0.00	0.00
02/09/06	0.00	0.00	0.00
02/22/06	0.00	ND	0.00
02/27/06	0.00	0.00	0.00
03/14/06	0.01	NM	NM
03/16/06	0.00	0.02	0.00
03/21/06	0.03	0.00	0.00
03/28/06	0.00	ND	0.00
04/04/06	0.01	0.02	0.00
04/20/06	0.01	NM	0.00
04/25/06	0.00	0.00	0.00
05/02/06	0.03	0.02	0.00
05/11/06	0.03	ND	0.00
05/17/06	0.03	0.00	0.00
05/23/06	0.03	ND	0.00
06/07/06	0.03	0.00	0.06
06/13/06	0.00	0.00	0.03
06/28/06	0.00	ND	0.02
07/11/06	0.06	0.00	0.07
07/18/06	0.00	0.00	0.05
07/25/06	0.02	ND	0.05
08/01/06	0.02	ND	0.19
08/08/06	0.01	0.00	0.27
08/15/06	0.01	0.02	0.01
08/22/06	0.14	0.01	0.01
09/05/06	0.01	0.01	0.01
09/12/06	0.02	0.01	0.06
09/19/06	0.02	0.00	0.12
09/21/06	0.02	0.02	0.02
09/27/06	0.03	0.02	0.09
10/02/06	0.01	0.02	0.06
10/16/06	0.02	0.02	0.05
10/24/06	0.00	0.00	0.03
11/01/06	0.01	0.00	0.02
11/15/06	0.02	ND	0.08
12/05/06	0.00	0.00	0.02

Table 66. SWMU 8 LNAPL Thicknesses (ft)

Date	MW-132	MW-214	MW-215
12/13/06	ND	0.00	0.02
12/19/06	0.00	NM	0.00
01/04/07	0.00	0.00	0.04
01/16/07	0.00	0.00	0.02
01/23/07	0.00	0.02	0.08
01/30/07	0.00	0.00	0.01
02/13/07	0.00	0.00	0.06
02/21/07	ND	0.00	0.00
02/27/07	0.00	0.00	0.01
03/13/07	0.00	0.00	0.00
03/22/07	0.00	0.00	0.00
03/27/07	ND	ND	0.01
04/05/07	ND	0.00	0.00
04/12/07	ND	0.04	ND
04/19/07	ND	ND	ND
04/24/07	ND	ND	ND
05/01/07	0.00	0.04	0.01
05/08/07	ND	0.00	0.00
05/15/07	ND	ND	0.01
05/22/07	ND	ND	ND
05/31/07	ND	ND	0.00
06/05/07	ND	ND	0.00

ND = Not Detected

NM = Not Measured

6.91 Comment 91**RFI Section: 8.1.4.5, Figure 8-6****Comment Letter Page: 13**

The downgradient extent of this contamination is not delineated (toward the northeast or north). Chevron shall collect ground water samples downgradient from this area along the Hess property boundary. If necessary, Chevron shall continue to delineate this contamination onto the Hess property.

Chevron Response

Chevron is planning to conduct further work along the AHC property boundary as part of the CMS (see response to Comment 90). However, it is likely that the free product (and associated dissolved phase contamination) detected on groundwater in monitoring wells along the northeastern edge of SWMU 8 originated from the AHC property at 1 State Street in Perth Amboy (Appendix J).

AHC has been actively monitoring the groundwater downgradient of Chevron's SWMU 8 since 1996 (AHC, 2003). AHC's Remedial Investigation and Groundwater Sampling Progress Reports indicate that the distribution of benzene in groundwater depicted in Figure 37 is delineated on the AHC property by AHC well MW-5 (See Appendix J). Based upon the limited aerial extent of dissolved benzene, and the north-northeastward groundwater flow direction in the vicinity of Chevron's SWMU 8 wells and AHC's well MW-5 (as determined by both Chevron and AHC) dissolved groundwater contamination in the this vicinity appears to be isolated and possibly controlled by the swale located between the two properties.

Based on these findings, Chevron feels that no additional monitoring wells are warranted and plans to continue monitoring this area as part of the present site-wide groundwater monitoring network.

6.92 Comment 92**RFI Section: 8.1.4.5, page 269, #3****Comment Letter Page: 13**

Chlorobenzene has been found in this area. Chlorobenzene has a density of 1.1066 and can be present in the environment as a dense non-aqueous phase liquid (DNAPL). Chevron shall delineate the vertical extent of chlorobenzene contamination in this area. Chevron shall determine the source of chlorobenzene contamination in ground water.

Chevron Response

As reported in the RFI Report, SWMU 8 is associated with a TEL burial. Based on the results of the RFI and SRFI, the soil and groundwater contamination associated with the burial is limited in extent, and not a likely source of dissolved chlorobenzene concentrations in the vicinity. However, a more likely source for dissolved chlorobenzene in the vicinity is an LNAPL plume, identified through the presence of product in groundwater monitoring wells MW-132, MW-214, and MW-215. As discussed in the response to Comment 90, product samples were collected from MW-132, MW-214, and MW-215. The product was determined to have characteristics consistent with No. 2 fuel oil. This area of the Refinery has never been associated with the production, storage, or handling of No. 2 fuel oil and its presence may be the result of on-site migration from an off-site source.

The chlorobenzene detected in the groundwater during the RFI occurs in two samples at concentrations of 580 µg/L and 1,100 µg/L. The recently installed and current monitoring wells were re-sampled to confirm the presence of chlorobenzene during the SRFI in the vicinity of SWMU 8. During the SRFI, one permanent deep monitoring well, MW-252, was installed in the vicinity of SWMU 8 (see Figure 34).

An SRFI soil boring (S2315) was advanced at the MW-252 monitoring well location prior to well installation to obtain lithologic and OVM screening data. Following lithologic and OVM data collection, a deep monitoring well was installed in the soil boring following installation procedures addressed in the response to Comment 2.

The steel casing for deep monitoring well MW-252 was set six feet into a clay confining layer, encountered at 8.0 ft. bgs. The PVC screen was set from 25.0 to 30.0 ft bgs. Following groundwater gauging, a sample was collected from MW-252, and analyzed for VOCs, SVOCs, and metals.

Groundwater sample M252A1 from MW-252 contained no dissolved VOCs or SVOCs in concentrations exceeding the SRFI Evaluation Criteria. With specific regard to Comment 92, no chlorobenzene was detected in sample M252A1 above the MDL. Therefore, vertical delineation of chlorobenzene is complete.

In April 30, 2003 AHC sampled the monitoring well network at their property (1 State Street) adjacent to Chevron's EY including SWMU 8 (Appendix J). Specifically, AHC well MW-5 which is located within 100 feet of SWMU 8's shallow monitoring well MW-132. On that date, groundwater samples collected at AHC well MW-5 exhibited benzene (260 µg/L), chlorobenzene (377 µg/L), cis-1,2-dichloroethene (209 µg/L), and vinyl chloride (87.7 µg/L) above NJDEP GWQS (AHC, 2003).

Historically, chlorobenzene concentrations in adjacent shallow well MW-132 have been gradually decreasing through time with the highest observed concentration in that well (580 µg/L) on November 14, 2002 (M132A1). The most recent sample collected on September 7, 2006 (M132A8) contained a concentration of chlorobenzene (47 µg/L) below the revised SRFI Evaluation Criteria (50 µg/L). Unlike AHC well MW-5, neither cis-1,2-dichloroethene or vinyl chloride have ever been detected at Chevron well MW-132. As such, Chevron suspects that the groundwater contamination at MW-5 emanates from the AHC property and not Chevron.

Based on these findings, Chevron will continue to sample SWMU 8 monitoring wells as part of its routine monitoring program. In addition, Chevron will continue to monitor AHC's Investigations at 1 State Street in Perth Amboy, NJ.

6.93 Comment 93**RFI Section: 8.1.4.6, Figure 8-6****Comment Letter Page: 13**

Chevron shall collect additional ground water samples downgradient from H0354. This hydropunch sample contained 690 ug/L of benzene. The additional samples shall be collected between H0386 and H0881 to verify that a benzene plume does not extend between these two sampling points.

Chevron Response

Please see Comment 67.

6.94 Comment 94**RFI Section: 8.1.4.7, page 271, #3****Comment Letter Page: 13**

Chevron states "Some earlier hydropunch results such as the 1,100 ug/L of benzene detected in H0218 have not been substantiated by analysis of groundwater samples collected from wells. MW-144 was placed near the location of H0218 and has been non-detect for benzene for two rounds of samples". The Department notes that, according to figure 8-6, MW-144 is approximately 30 feet and sidegradient from H0218. Chevron shall install a monitor well at the location of H0218 and add it to the proposed monitoring program for this area. Chevron shall perform additional ground water investigations to determine the location of the edge of the contamination at H0218 in the northerly (sidegradient) and easterly (downgradient) directions.

Chevron Response

Please see Comment 68.

6.95 Comment 95**RFI Section: 8.1.4.7, Figure 8-6****Comment Letter Page: 13**

Permanent monitor wells are required downgradient from RW-83. Chevron shall perform additional investigations to determine the location of the edge of the contaminant plume in this area. After the edge of contamination is found, Chevron shall install permanent monitor wells to monitor contaminant trends at the plume fringe.

Chevron Response

Please see Comment 68.

6.96 Comment 96**RFI Section: 8.1.4.8, page 272, #3****Comment Letter Page: 13**

Chevron indicates that the source of ground water contamination in monitor well MW-6 is uncertain. Chevron indicates that the contamination may be from an upgradient source. Chevron shall determine if monitor wells are located on the ASARCO property. If monitor wells are present, and are constructed in the same water-bearing zone, Chevron shall collect synoptic water level data from the Chevron East Yard and ASARCO properties. Chevron shall submit a ground water contour map depicting ground water flow direction across the two properties. These data and maps shall be submitted to the Department for review.

Chevron Response

As presented in Section 5.4.6, as part of the SRFI, Chevron installed two temporary monitoring wells (H1003 and H1004) in the vicinity of MW-6 along the Chevron and ASARCO property boundary, in the southern portion of the EY (see Figure 37). These temporary monitoring wells were screened across the water table, or deeper, to intersect impacted soil intervals. No sand pack or bentonite seal was used during temporary well installation, and the well was not developed prior to sampling. Each temporary well was surveyed using a portable global positioning system as described in the SRFI DWP. A detailed boring log for each SRFI temporary monitoring well location is included in Appendix A.

Temporary well H1004 was installed within 10 feet of MW-6, and was advanced to a depth of 20.0 ft. bgs. No OVM readings above 0 ppm were recorded at this location, and the temporary well screen was set between 10.0 and 12.0 ft. bgs. A groundwater grab sample, H1004, was collected on December 15, 2006 and analyzed for VOCs. Dissolved benzene (4 µg/L) was detected at a concentration exceeding the SRFI Evaluation Criteria (1 µg/L), thus confirming groundwater contamination within the vicinity of MW-6. In addition, the analytical results for H1004 indicate that groundwater samples collected at MW-6 are representative of that screened interval (5.0 to 20.0 ft. bgs), despite its 15 foot screen interval.

Temporary monitoring well H1003 was located approximately 100 feet east and sidegradient to H1004, and was advanced to a depth of 20.0 ft. bgs. No OVM readings above 0 ppm were observed at this location, and the temporary well screen was set between 16.0 to 18.0 ft bgs. A groundwater grab sample, H1003, was collected on December 15, 2006 and analyzed for VOCs. No dissolved VOCs were detected in concentrations exceeding the SRFI Evaluation Criteria. Based on the installation and analytical data collected from H1004 and H1003, dissolved phase contamination appears to be limited in aerial extent surrounding MW-6 and H1004. Figure 37 depicts the distribution of benzene in groundwater in the vicinity of MW-6, including temporary wells H1003 and H1004 and surrounding wells sampled in 2007.

As additionally required in Comment 96, Chevron conducted a file review pertaining to the former ASARCO site, located adjacent to the south of Chevron's property. Two Remedial Investigation Reports (RIRs), dated May 1999 and June 2002, were examined to determine the groundwater flow direction, and the nature and extent of dissolved phase groundwater contamination across this property boundary (see Appendix K). A total of 15 groundwater monitoring wells were identified in these reports on the ASARCO property. Of these wells, only ASARCO well number MW-7R is in close proximity to Chevron's MW-6. Based on the May 1999 and June 2002 RIRs, ASARCO's MW-7R has not been sampled for VOCs. Both RIRs include shallow groundwater contour maps which indicate groundwater flow is eastward, towards the Arthur Kill. No additional information was available from ASARCO regarding dissolved phase VOC groundwater contamination in this vicinity. Chevron's computer modeling predicts a limited aerial extent of dissolved benzene contamination in the MW-6 and H1004 vicinity due to the relatively low concentration of benzene in these wells (Figure 37). Based upon the limited aerial extent of dissolved benzene, and the eastward groundwater flow direction in the vicinity of Chevron's MW-6 and ASARCO's MW-7R, as determined by both Chevron and ASARCO, dissolved groundwater contamination in the MW-6 vicinity is isolated.

6.97 Comment 97**RFI Section: 8.1.4.9, page 273, H0406****Comment Letter Page: 14**

Chevron shall collect three ground water samples within 20 feet and downgradient from H0406. The samples are required to characterize the potential ground water contaminant plume in this area. If the samples are clean, Chevron shall install a permanent monitor well at the location and add it to the regular monitoring program. If the samples are contaminated, then Chevron shall perform additional delineation until the plume is fully delineated and characterized.

Chevron Response

H0406 is an isolated historical detection of benzene. Other samples collected in the immediate vicinity did not contain compounds in excess of the GWQC. Chevron feels this is a low priority that has been sufficiently monitored from downgradient wells.

6.98 Comment 98**RFI Section: 8.1.4.9, page 273, H0448 and H0359****Comment Letter Page: 14**

Chevron shall collect three ground water samples within 20 feet and downgradient from H0448. According to figure 8-6, there are no downgradient ground water samples within 200 feet of this sample location. If the samples are clean, Chevron shall install a permanent monitor well at the location and add it to the regular monitoring program. If the samples are contaminated, then Chevron shall perform additional delineation until the plume is fully delineated and characterized.

Chevron Response

H0448 is an isolated detection of benzene that is located upgradient from an LNAPL area that has received significant attention. Chevron feels this is a low priority that has been sufficiently monitored from downgradient wells. Chevron conducted additional field screening in this area associated with AOI 2. A temporary monitoring well (H1005) was installed to facilitate the collection of a groundwater sample downgradient of H0448. The screen was set across the water table (9.5 to 11.5 ft. bgs) to intersect impacted soil intervals.

During the SRFI, a groundwater sample was collected from H1005 and existing nearby permanent wells. The results of the sampling are depicted in several SRFI COC site-wide distribution maps which include arsenic, ammonia, benzene, cyclohexane, lead, and methylcyclohexane (see Figure 35 through Figure 40, respectively). Appendix G presents all laboratory analytical data for all groundwater monitoring wells, including dissolved metals concentrations, and their respective SRFI Evaluation Criteria.

The groundwater grab sample H1005, collected from the temporary well H1005 in AOI 2 contained concentrations of VOCs in excess of the SRFI Evaluation Criteria. Sample H1005 contained benzene (10 µg/L), cyclohexane (590 µg/L), ethylbenzene (780 µg/L), and methylcyclohexane (420 µg/L) in excess of the SRFI Evaluation Criteria (1 µg/L, 100 µg/L, 700 µg/L, and 100 µg/L, respectively), and was collected from a two foot screen interval, set 9.5 to 11.5 ft. bgs. Temporary monitoring well H1005 was located approximately 40 feet northeast of Tank 760.

Based on these findings, Chevron feels that no additional monitoring wells are warranted and plans to continue monitoring this area as part of the present site-wide groundwater monitoring network.

6.99 Comment 99**RFI Section: 8.2.1, page 274, #3****Comment Letter Page: 14**

Chevron indicates that there are discontinuous deposits of light gray sands and clays at depths of 15 to 25 feet within the till. The glacial sediments map of New Jersey DGS96-1 Glacial Sediments of New Jersey available at the following link indicates that deltaic or glacial melt water deposits are present beneath the Chevron refinery:

<http://www.state.nj.us/dep/njgs/geodata/dgs96-1.htm>

Chevron should clarify whether these deposits can be described as deltaic. Chevron should be aware that this potential preferential flow path needs to be delineated as it may be an important feature in the site conceptual model. The Department notes that this feature is present at the location of a ground water depression (see Figure 8-10). Chevron shall determine if there is a downward vertical head in this area.

Chevron Response

Please see the response to Comment 2 in regard to downward vertical head in the NF/MY. Chevron is currently developing a site-wide geologic model that will address this concern. Once completed, this geologic model will be presented to EPA and NJDEP for review.

6.100 Comment 100**RFI Section: 8.2.3.2, page 285, 1st #****Comment Letter Page: 14**

Chevron states that MTBE was detected in MW-117 but was never used at the refinery. Since this compound is not detected in background monitor wells, and Chevron stored gasoline on-site, the Department must consider MTBE to be a site-related contaminant.

Chevron Response

Please see the response to Comment 78. Chevron reasserts that MTBE was not used at the Chevron Perth Amboy Refinery. Production of gasoline was terminated at the Refinery in 1983 prior to the general use of MTBE as an additive. Chevron believes the limited detections of MTBE at the Refinery support this claim. Chevron does agree to continue to include MTBE in the periodic groundwater monitoring program. It is expected that investigation efforts that have been conducted and those that are planned will supply the necessary information concerning MTBE.

6.101 Comment 101**RFI Section: 8.2.3.2, page 285, last #****Comment Letter Page: 14**

Chevron states "MW-180 is a deeper well screened in the first water bearing zone beneath the fill/native interface". The concentrations of VOCs in this well indicate that vertical delineation has not been accomplished in the North Field/Main Yard. Chevron shall complete vertical delineation of contamination to complete the RFI.

Chevron Response

Chevron agrees with the NJDEP that vertical delineation was not supplied by MW-180. MW-180 has since been abandoned and MW-187 has been installed in virtually the same location. MW-187 does provide vertical delineation for contamination detected at NF-10. Chevron plans to include wells NF-10 and MW-187 in the groundwater monitoring program, which would include semi-annual sampling and quarterly gauging. Please see Comment 56 for a more detailed discussion on this subject. In addition, please read Comment 2 on other site-wide vertical delineation activities and findings during the SRFI.

6.102 Comment 102**RFI Section: 8.2.3.2, page 288, #2****Comment Letter Page: 14**

Chevron states that further assessment of the North Field/Main Yard groundwater relating to VOCs should be focused on benzene. The purpose of the RFI is to delineate all ground water contamination not just benzene. Chevron must consider not only relative toxicity of a compound but also persistence and mobility in the environment. Therefore, in areas where there are more persistent or more mobile chemicals present in ground water, these chemicals must be considered. In addition, Chevron is responsible to cleanup all ground water contamination at this site. Therefore, all ground water contamination must be considered during the corrective measures study.

Chevron Response

Chevron understands NJDEP's concern and does not mean to imply that compounds other than benzene will be ignored. Benzene is the most widely distributed compound at the Refinery. In almost every occurrence where contaminants of any kind are detected, benzene is also detected. Therefore, it is a convenient "indicator compound", and is used as such by Chevron.

During the SRFI, groundwater samples were collected from all new SRFI wells, CMS wells, and existing nearby wells. These wells were typically analyzed for a full list of parameters including VOCs and other TCL parameters. The results of this sampling is depicted in several SRFI COC site-wide distribution maps which include arsenic, ammonia, benzene, cyclohexane, lead, and methylcyclohexane (see Figure 35 through Figure 40, respectively). Appendix G presents all laboratory analytical data for all groundwater monitoring wells, including dissolved metals concentrations, and their respective SRFI Evaluation Criteria.

6.103 Comment 103**RFI Section: 8.2.3.2, page 288, last #****Comment Letter Page: 14**

The boundaries of the contaminant plumes are difficult to distinguish at the scale at which Figure 8-16 is presented. In addition, it is difficult to determine if horizontal delineation of ground water contamination is complete on figure 8-16. Chevron shall submit a map for each contaminant plume area at a scale of 1 inch to 40 feet or less pursuant to N.J.A.C. 7:26E-4.2b3i. Chevron shall submit these maps for each contaminant plume area including the East Yard and Central Yard.

Chevron Response

During the SRFI, groundwater samples were collected from all new SRFI wells, CMS wells, and existing nearby wells. The results of this sampling is depicted in several SRFI COC site-wide distribution maps which include arsenic, ammonia, benzene, cyclohexane, lead, and methylcyclohexane (see Figure 35 through Figure 40, respectively). Appendix G presents all laboratory analytical data for all groundwater monitoring wells, including dissolved metals concentrations, and their respective SRFI Evaluation Criteria.

Please note that Figure 35 through Figure 40, as well as other figures throughout this report, are presented at a larger scale than 1 inch to 40 feet. This scale was accommodated wherever possible, but often, it was not possible to fit a map of the entire Refinery on an E size piece of paper at a scale of 1 inch to 40 feet. However, every effort was made to ensure that all maps are legible, regardless of the scale size.

6.104 Comment 104**RFI Section: 8.2.3.2, page 289, last #****Comment Letter Page: 14**

Chevron notes several instances where benzene concentrations have decreased when a comparison between hydropunch samples collected in 1997 and monitor well samples collected in 2002 is made. The Department notes that hydropunch samples and monitor well samples may not be comparable if contamination is stratified. The small screen length of the hydropunch may give much higher results than the longer screened interval of a monitor well. Several factors may account for this including: improper placement of sampling pump during low flow sampling, mixing of relatively clean ground water with more contaminated ground water during 3 to 5 volume purge sampling and/or improper placement of screened interval of monitor well. As stated above Chevron shall perform a detailed comparison of hydropunch and monitor well samples to determine the cause of the significantly lower concentrations of contaminants in monitor wells.

Chevron Response

Please refer to Chevron's response to Comment 71.

6.105 Comment 105**RFI Section: 8.2.3.2, page 290, #1****Comment Letter Page: 15**

Chevron states that a depression in the water table centered on Tanks 327 and 301 is apparent. It appears that this depression is caused by pumping ground water from the OWSS out of the basin and up the effluent treatment plant (ETP). Chevron should clarify whether or not water is constantly being pumped from this basin to the ETP.

Chevron Response

Water from sumps located in the NF is not pumped continuously. The sumps are part of the stormwater management system at the Refinery and are used to periodically remove water from the tank basins as necessary.

6.106 Comment 106**RFI Section: 8.2.3.2, page 291, #1****Comment Letter Page: 15**

Chevron states that there is evidence that VOC concentrations in ground water have been declining over the past five years. The Department believes that the referenced evidence is the result of sampling technique and not the result of actual contaminant decrease.

Chevron Response

Chevron does not believe that any apparent reduction in VOC concentrations is the result of sampling technique. Chevron utilized a consistent sampling procedure throughout the RFI investigation, and continues to utilize the same procedure for current groundwater monitoring activities. Please refer to Chevron's response to Comment 40 for a discussion of the groundwater sampling procedure.

Accordingly, it is expected that consistency in sampling procedure would produce consistency in VOC sample results. Therefore, any increase or decrease in concentration between sampling events is due to an actual increase or decrease in groundwater VOC concentrations. Please refer to Comment 50 for a discussion of LNAPL influenced VOC concentrations in this area.

Complete sample results for monitoring wells in the NF4/NF5/NF6 area can be found in Appendix G.

6.107 Comment 107**RFI Section: 8.2.4.2, page 291, #5****Comment Letter Page: 15**

Chevron indicates that high concentrations of VOC were detected in MW-179. According to figure 8-10, ground water flow direction in this area is toward the north, northeast or northwest. Chevron has not collected ground water samples north of MW-179. Therefore, Chevron shall delineate the extent of contamination found in MW-179 in the northern direction. After delineation is completed, Chevron shall install permanent monitor wells to monitor the ground water plume.

Chevron Response

During the SRFI, Chevron conducted a detailed assessment of on-site wells which were being used to determine groundwater flow direction site-wide. This assessment included categorizing each well based on the elevation of its well screen and its relationship with corresponding geologic units. Following this assessment, Chevron developed separate groundwater contour maps for the shallow and deep water-bearing units beneath the site (see Figure 33 and Figure 34). In addition, Chevron evaluated the distribution of COCs in groundwater and installed additional shallow and deep permanent monitoring wells in the NF/MY. One of these new shallow SRFI wells was MW-192 located in former Tank Basin 311 (see Section 5.3.1). Well MW-192 was installed approximately 200 feet northwest of former Tank Basin 314, where well MW-179 is located.

During the SRFI, groundwater samples were collected from all new SRFI and CMS wells and selected existing wells site-wide, including wells MW-179, MW-192, and MW-159 located in Tank Basin 315 to the northeast. MW-159 was sampled eight times between 2002 and 2007, and MW-192 was sampled twice in the first half of 2007. No VOCs were detected in excess of the SRFI Evaluation Criteria at either well. The results of this sampling event are depicted in several SRFI COC site-wide distribution maps which include arsenic, ammonia, benzene, cyclohexane, lead, and methylcyclohexane (see Figure 35 through Figure 40, respectively). Figure 37 depicts the distribution of benzene in the vicinity of well MW-179 as delineated with the existing network of monitoring wells. MW-179 has been sampled eight times between 2002 and 2007. VOC exceedances of benzene (7), cyclohexane (7), ethylbenzene (1), methylcyclohexane (4), and xylene (1) have been detected in these samples. However, there have been no exceedances of VOC compounds where the benzene criteria was not also exceeded, making it a good indicator compound. Appendix G presents all laboratory analytical data for all groundwater monitoring wells, including dissolved metals concentrations and their respective SRFI Evaluation Criteria.

With the installation of well MW-192 and existing well MW-159 located to the northeast of MW-179, Chevron believes there are an adequate number of wells in this area and additional wells are not needed to provide delineation. Chevron plans to continue monitoring benzene in this area and report their findings.

6.108 Comment 108

RFI Section: 8.2.4.3

Comment Letter Page: 15

Chevron's proposal for continued monitoring in this area is acceptable.

Chevron Response

Chevron acknowledges NJDEP's approval for continued monitoring. Please see Section 5.3.

6.109 Comment 109

RFI Section: 8.2.4.4, page 295

Comment Letter Page: 15

Chevron indicates that ground water contamination was found in deep monitor well MW-180. The horizontal and vertical extent of this contamination must be delineated.

Chevron Response

Please see Chevron's response to Comment 56 which addresses horizontal and vertical delineation of contamination in this vicinity.

6.110 Comment 110**RFI Section: 8.2.4.4, page 295, #2****Comment Letter Page: 15**

Chevron indicates that ground water flow is towards Tank Basin 302 and 330 in this area potentially due to a sump. In addition to this possibility, Chevron shall determine if there is a downward vertical gradient between monitor well MW-10 and MW-180.

Chevron Response

Since the submittal of the RFI Report in November 2003, Chevron has abandoned MW-180. Chevron was concerned that the screened interval of MW-180 was inappropriate and that a replacement well should be installed and screened at a deeper interval. As such, Chevron replaced MW-180 with a deep well (MW-187) on March 30, 2004 which was coupled with a nearby shallow monitoring well (NF-10). Since well MW-187 was installed between the submittal of the 2003 RFI Report and before the 2006 SRFI, this well does not appear in the appendices of this report. However, the well construction information is shown below in Table 67 along with wells MW-180 and NF-10.

Please see Chevron's response to Comment 56 for a detailed description of the vertical gradient calculated between these wells, and Comment 2 for a description of vertical gradients calculated across this area.

Table 67. Monitoring Well Construction Details

Well ID	Yard	Install Date	TOS (ft. bgs)	BOS (ft. bgs)	Steel Casing (ft. bgs)	Elev. TOS (ft)	Elev. BOS (ft)	Grnd. Elev. (ft)	MPE (ft)
MW-180	MY	3/18/03*	16.50	26.50	16.00	-9.10	-19.10	7.4	9.72
MW-187	MY	3/30/04	29.00	34.00	29.00	-21.80	-26.80	7.20	9.70
NF-10	MY	7/7/92	3.00	13.00	N/A	4.08	-5.92	7.08	9.22

TOS = Top of Screen

BOS = Bottom of Screen

Elev. = Elevation

Grnd. = Ground Surface

MPE = Measuring Point Elevation

N/A = Not Applicable

*Well Abandoned on 10/7/03 by a NJ Licensed Driller

6.111 Comment 111

RFI Section: 8.2.4.4, page 296, last #
Comment Letter Page: 15

Chevron indicates that additional investigation will be conducted for the ground water contamination found in monitor well MW-180. Chevron indicates that a report will be submitted after this investigation is completed. The proposal is acceptable.

Chevron Response

Chevron acknowledges NJDEP's acceptance of the proposal. Please see Chevron's response to Comment 56, which addresses horizontal and vertical delineation of contamination in the vicinity of well MW-180 (please see Section 5.3 as well).

6.112 Comment 112**RFI Section: 8.2.4.4, page 297, #2****Comment Letter Page: 15**

Chevron proposes to abandon monitor well MW-180 since it may screen two separate water-bearing zones. This proposal is acceptable provided that MW-180 is replaced with two monitor wells (one for each zone currently monitored by MW-180).

Chevron Response

Chevron replaced MW-180 with deep monitoring well MW-187. This deep well is paired with shallow monitoring well NF-10. Please refer to Comments 2, 56 and 110 for details regarding analysis of this well pair.

6.113 Comment 113**RFI Section: 8.2.4.5, page 297****Comment Letter Page: 15**

Chevron proposes to continue monitoring this contamination. This proposal is acceptable. The Department withholds comment concerning delineation of this area until a large-scale map of the area, as required above, is submitted showing sampling results and ground water flow direction. According to figure 8-10, it appears that inadequate sampling has been performed to the north. However, ground water contours for the immediate area surrounding MW-133 are not shown, and no water level measurement is available.

Chevron Response

Due to physical structures to the north of MW-133, the placement of additional wells in this area is very limited (see Figure 3). Regardless, it remains Chevron's opinion that the minimal exceedances of benzene in this area are sufficiently monitored (see Figure 37 and Section 5.3).

6.114 Comment 114

RFI Section: 8.2.4.6, page 298, last #
Comment Letter Page: 16

Chevron states "The only results that are of limited concern are the detection of benzene at 1 ug/L in MW-165 and 12 ug/L of dichloroethene in MW-164. These results will be confirmed or not confirmed in the next round of samples". The purpose of the RFI is to delineate the extent of contamination. Chevron shall collect confirmation samples in this area, if after these samples are collected, delineation is not complete, Chevron shall complete delineation and begin an investigation on the potential impact of this area on Spa Spring Creek.

Chevron Response

During the SRFI, Chevron conducted a detailed assessment of on-site wells which were being used to determine groundwater flow direction site-wide. This assessment included categorizing each well based on the elevation of its well screen and its relationship with corresponding geologic units. Following this assessment, Chevron developed separate groundwater contour maps for the shallow and deep water-bearing units beneath the site (see Figure 33 and Figure 34). In addition, Chevron evaluated the distribution of COCs in groundwater and installed additional shallow and deep permanent monitoring wells in the NF/MY.

During the SRFI, groundwater samples were collected from all new SRFI and CMS wells and selected existing wells site wide. The results of this sampling event are depicted in several SRFI COC site-wide distribution maps which include arsenic, ammonia, benzene, cyclohexane, lead, and methylcyclohexane (see Figure 35 through Figure 40, respectively). In regard to benzene at well MW-165, Figure 37 depicts the distribution of benzene in this area as delineated with the existing network of monitoring wells in 2007. The SRFI Screening Criteria for cis-1,2-dichloroethylene is 70 µg/L.

Confirmation samples from MW-164 were taken between October 2003 and May 2007 (see Table 68). All results for cis-1,2-dichloroethylene were below the SRFI Evaluation Criteria; therefore, delineation has been achieved. Appendix G presents all laboratory analytical data for all groundwater monitoring wells.

Delineation of these groundwater impacts has been completed to the extent needed to allow for this area's inclusion and evaluation as part of the CMS. Final assessment of the aerial extent of impacted groundwater in this area, and its potential impact on Spa Spring Creek, will be completed during the subsequent CMS PDI sampling program.

Table 68. cis-1,2-Dichloroethylene Concentrations at MW-164

Sample ID	Sample Date	cis-1,2-Dichloroethylene (µg/L)
M164A1	4/17/03	12
M164A2	10/1/03	24
M164A3	9/21/04	30
M164A4	5/24/05	30
M164A5	10/25/05	29
M164A6	5/23/06	35
M164A7	11/2/06	30
M164A8	5/17/07	31

6.115 Comment 115**RFI Section: 8.2.4.6, page 299, #1****Comment Letter Page: 16**

Chevron states "if the levels of benzene and/or other constituents fall below the delineation criteria for two consecutive rounds, the (ground water) sampling will be discontinued". The NJDEP cannot concur with this proposal at this time. Chevron shall continue to monitor ground water quality in this area until source remediation has been completed and is shown to be successful.

Chevron Response

Chevron agrees to ongoing monitoring of the SWMA 1 wells for the present (see Section 5.3). Figure 35, Figure 36, Figure 37 and Figure 39 depict the distribution of ammonia, arsenic, benzene, and lead in the vicinity of SWMA 1, respectively.

6.116 Comment 116**RFI Section: 8.2.4.6, page 299, last #****Comment Letter Page: 16**

Chevron states "regardless of flow direction, MW-39 is surrounded by clean wells". The Department does not concur as according to figure 8-16, MW-137 has 280 ug/L benzene. It is noted that MW-137 is over 200 feet from MW-0039. Chevron shall characterize the extent of ground water contamination between MW-0039 and MW-137. After the extent of contamination has been determined, Chevron shall install permanent monitor wells in this area to monitor contaminant trends.

Chevron Response

Chevron apologizes for the confusion concerning MW-137. The 280 µg/L of benzene presented on Figure 8-6 is associated with temporary well point H0238 and not MW-137. MW-137 was initially installed to investigate the presence of benzene at this location. However, through two rounds of sampling, the data does not indicate the presence of VOCs in excess of the SRFI Evaluation Criteria.

6.117 Comment 117**RFI Section: 8.2.4.6, page 300, #3****Comment Letter Page: 16**

Chevron states that they will analyze ground water samples for VOC only during the continuing monitoring program. The Department does not concur as metals have been detected, albeit sporadically.

Chevron Response

Chevron agrees to add arsenic, lead, and thallium analysis to the ongoing monitoring of wells in MY2. Please see Section 5.3 and Figure 36 and Figure 39 which depict the distribution of arsenic and lead, respectively, in the MY.

6.118 Comment 118**RFI Section: 8.3.2, page 302****Comment Letter Page: 16**

Chevron does not discuss hydrogeology of the glacial till. The hydrogeology of the till is important since, based on cross section 8-21, ground water from the fill layer discharges into the till layer and sand horizon A. Vertical gradients and horizontal gradients within the till layer need to be better defined and discussed so that an accurate site conceptual model may be constructed.

Chevron Response

During the investigation of AOC 36 in the southern portion of the CY, Chevron studied in depth the hydrogeology of the glacial till in this area. As a result, an accurate site conceptual model was developed. CEMC submitted this model to EPA and NJDEP for review on August 25, 2005 as part of the AOC 36 Triad-Based Chlorinated Plume Investigation Report.

6.119 Comment 119**RFI Section: 8.3.4.1, page 313, #5****Comment Letter Page: 16**

Chevron indicates that the benzene detected in monitor well MW-108 is delineated to the west and south. However, delineation is not completed to the east and southeast in the direction of ground water flow. Chevron shall collect additional ground water samples southeast of MW-108 to confirm that MW-108 represents worst-case ground water contamination. If no additional ground water contamination is present, Chevron's proposal for continued monitoring will be acceptable to the Department.

Chevron Response

Chevron has completed additional field screening southeast of MW-108 as part of the AOC 36 investigation conducted in the southern portion of the CY. Additional wells were installed east and southeast of MW-108, for example (wells MW-183 and MW-230) since the Full RFI. Figure 37 depicts the distribution of benzene in the CY based on the latest data set generated in 2006 from these wells. Based on Chevron's findings, the occurrence of benzene at well MW-108 has not increased or decreased since 2002 and its occurrence appears to be isolated to the SWMU 15 vicinity. The occurrence of higher concentrations of benzene to the south of SWMU 16 at AOC 22 appears to be unrelated.

6.120 Comment 120**RFI Section: 8.3.4.1, page 314, #1****Comment Letter Page: 16**

Chevron indicates that they will continue to monitor pH in MW-111, however, the metals contamination is not delineated. Chevron must also delineate the extent of metals contamination in ground water in this area as well as the low pH with which it appears to be associated.

Chevron Response

Since the Full RFI, Chevron has been monitoring the groundwater at well MW-111 for pH, as shown in Table 69.

Table 69. MW-111 pH Data

Sample Month & Year	pH
October 2002	4.80
March 2003	3.87
February 2004	3.51
September 2004	4.46
May 2005	3.35
September 2005	4.12
June 2006	3.58
October 2006	4.33

The pH values have been consistently low. Nearby wells MW-106, MW-108, and MW-110 have been exhibiting higher pH values (between 5.00 and 8.00) over the same time period. The low pH is a concern. Chevron will continue to monitor these wells and delineate the extent of metals contamination (e.g., cobalt, nickel, and thallium) in groundwater in this area (AOC 32) as part of the site-wide monitoring program. Chevron's findings will be reported to EPA and NJDEP in upcoming Quarterly Progress Reports.

6.121 Comment 121

RFI Section: 8.3.4.2, page 314, last #
Comment Letter Page: 16

In addition to the proposed additional activities, Chevron shall install three monitor wells at locations within 20 feet and downgradient from the LNAPL plume in this area to monitor any potential for dissolved contaminants to migrate from the area. Samples from the monitor wells shall be analyzed for TCL VO, TCL SVO and TAL metals.

Chevron Response

Please refer to Comment 60.

6.122 Comment 122

RFI Section: 8.3.4.3, page 315, last #
Comment Letter Page: 16

Chevron's proposal for continued monitoring in this area is acceptable.

Chevron Response

Chevron acknowledges NJDEP's acceptance of the proposal.

6.123 Comment 123**RFI Section: 8.3.4.4, page 317, #3****Comment Letter Page: 17**

Chevron's proposal to install and monitor MW-169R is acceptable. Depending on the outcome of the chlorinated plume delineation effort, the Department may require additional sampling and or monitor wells in this area.

Chevron Response

Chevron acknowledges NJDEP's acceptance of the proposal. Well MW-169R was installed by Chevron in 2004 along with additional monitoring wells and MIP and cone penetrometer (CPT) surveys downgradient onto neighboring properties. Chevron successfully delineated the chlorinated volatile organic compound (CVOC) plume and found no evidence of potential adverse impact to potential human receptors (on or off-site) via vapor intrusion (near-slab type) emanating from AOC 36. Based on current and future water use, the plume does not represent a threat to human health or any other potential environmental receptors. In addition, there is substantial evidence that the main axis of the CVOC plume is structurally confined to the southeast of the CY in the direction of groundwater flow and that natural attenuation is occurring. Finally, suspected non-Chevron CVOC spill sites were found at the northern State Street properties that appear to be contributing to the northeastern component of the Chevron CVOC plume in that vicinity. The State Street property owners participating in the investigation have been informed of our findings.

On August 25, 2005, CEMC submitted the AOC 36 Triad-Based Chlorinated Plume Investigation Report to representatives of the EPA and NJDEP for formal review. On March 6, 2006, CEMC submitted a supplemental report to EPA and NJDEP that focused on an additional field investigation to the east on the Sylvan property to provide better delineation of the chlorinated compounds found previously in that area downgradient of the Chevron property. The results of this investigation confirmed that delineation had been achieved and that another unrelated chlorinated plume was emanating from the Sylvan property.

On May 8, 2006, CEMC received letters from the EPA and NJDEP stating that CEMC's recommendations to continue monitoring the groundwater at AOC 36 until July 2006 was acceptable, that delineation had been achieved, and that the chlorinated plume does not pose a risk for vapor intrusion to any off-site properties.

Since the last submittal to EPA and NJDEP, Chevron has analyzed the data from the July 2006 sampling event. Figure 48 through Figure 58 depict the most recent distribution of VOCs and metals in the CY including AOC 36. Based on a comparison of these latest distribution maps to those previously submitted to the EPA and NJDEP, the hydrogeology (e.g., hydraulic gradients, flow directions, etc.) and the magnitude and extent of COCs have been validated and have been consistent.

Currently, Chevron is taking the following actions to continually monitor AOC 36 for natural attenuation:

- Conduct semi-annual groundwater modeling of Chevron wells associated with this investigation;
- Monitor groundwater for carbon dioxide, ethane, and ethene under USEPA and NJDEP guidance to monitor natural attenuation; and
- Conducted a carbon stable isotope study to determine if natural attenuation is a feasible remediation option (Hunkeler, et. al., 1999).

Appendix G presents all laboratory analytical data for all temporary and permanent groundwater monitoring wells, including dissolved metals concentrations, and their respective SRFI Evaluation Criteria.

In 2006, Chevron conducted a Compound Specific Isotope Analysis (CSIA) Study of AOC 36. Appendix L contains the CSIA Report titled Compound Specific Isotope Analyses to Support Monitored Natural Attenuation: Perth Amboy Facility Case Study prepared by Chevron's Tim Buscheck and Tim Hoelen (2007). Below are several statements from this report that summarizes their findings.

"The CSIA indicated that all detectable chlorinated compounds in groundwater at the CYA of the Perth Amboy Facility are being degraded. Therefore, monitored natural attenuation should be a viable management strategy for the CY. CSIA also elucidates the transformation pathways that are most significant for the formation and degradation of VC, and suggests the presence of an offsite source for chlorinated solvents. Tetrachloroethene (PCE) and trichloroethene (TCE) are transformed to ethene, with cis-1,2-dichloroethene (cis-DCE) and VC as transient intermediates. Likewise, 1,1,1-TCA is transformed to chloroethane, with 1,1-DCA as transient intermediate. Chloroethane is further degraded, likely to ethane. CSIA and concentration data also suggest that abiotic transformation of 1,1,1-TCA produces 1,1-dichloroethene (1,1-DCE), followed by reductive dechlorination to VC; this pathway is important to VC production.

In addition, there is evidence for an offsite source, based on elevated TCE concentrations in monitoring wells. Strongly negative ethene values in these offsite wells suggest this product has been more recently generated, consistent with the operating histories of these facilities. Very low methane concentrations in offsite wells provide additional evidence for incomplete reductive dechlorination. The absence of TCA and 1,1-DCA is further evidence for a distinct and different, chlorinated ethene-only, offsite source."

6.124 Comment 124

RFI Section: AOC 36, page 318, #1
Comment Letter Page: 17

Chevron proposes to install two wells, one screened in Sand Horizon A and a shallow well upgradient from the expected point of release for the chlorinated compounds.

Chevron Response

Chevron installed one well (MW-184) screened in Sand Horizon A and one shallow well (MW-183) upgradient of the expected source area in 2004. Please see Chevron's response to Comment 123 regarding the current status of AOC 36.

6.125 Comment 125

RFI Section: AOC 36, Page 318, #2
Comment Letter Page 17

Chevron's proposal to perform additional delineation in this area by use of field screening is acceptable to the Department.

Chevron Response

Chevron acknowledges NJDEP's acceptance of the proposal. Please see Chevron's response to Comment 123 regarding the current status of AOC 36.

6.126 Comment 126**RFI Section: Appendix A**
Comment Letter Page: 17

Chevron presents individual reports for SWMU/AOC in Appendix A. The NJDEP has only reviewed those reports for SWMU/AOC where a no further action for ground water request is made.

Chevron Response

Chevron acknowledges NJDEP's comment.

6.127 Comment 127

RFI Section: 1.2.2, page A-32

Comment Letter Page: 17

Based on the information provided, the proposed NFA for ground water is acceptable to the Department at this time.

Chevron Response

Chevron acknowledges NJDEP's acceptance of the NFA for groundwater.

6.128 Comment 128**RFI Section: A.2.7, page A-55****Comment Letter Page: 17**

Chevron states that lead was detected in ground water samples collected at H0442 but was not detected in samples collected from monitor well MW-127 collected via low flow purge methods. The Department notes that MW-127 is located approximately 40 feet from the location of the TEL burial. The request for no further investigation concerning ground water cannot be accepted at this time. A ground water sample shall be collected from the area of worst-case soil contamination.

Chevron Response

It is Chevron's position that all metal samples collected from temporary wells like H0442 are biased high since they are not properly filtered prior to laboratory analysis (e.g., MW-127 samples). Based on this rationale, Chevron cannot justify collecting a groundwater sample in the "area of worst-case soil contamination". Below is additional and more current information concerning lead in the vicinity of SWMU 7 (TEL Burials).

Based on a comparison of the occurrence of lead exceedances in soil and in groundwater in the vicinity of SWMU 7, Chevron feels no additional wells are necessary to monitor lead in this area. Figure 5 indicates lead exceedances in soil at borings S0808 and S0831 located at SWMU 7.

In comparison to Figure 39, the occurrence of lead in groundwater in this area is to the west of SWMU 7 at the new SRFI well MW-243. As shown on Figure 39, well MW-243 is neither downgradient nor upgradient of SWMU 7. However, wells MW-34, MW-126, and MW-127 are located downgradient of SWMU 7. Lead has not been detected in groundwater samples collected at these wells in 2007.

6.129 Comment 129**RFI Section: A.2.18, page A-151****Comment Letter Page: 17**

The ground water NFA request for SWMU 41 in table ES-1 cannot be accepted at this time. Ground water monitoring and remediation will be required in this area since LNAPL has been found.

Chevron Response

The LNAPL present within SWMU 41 is relatively small in aerial extent and mostly residual confined in the fill layer between 3.0 and 8.0 ft bgs. Chevron will address the residual LNAPL along with soil impacts at SWMU 41 during the CMS. However, several groundwater samples collected across SWMU 41 have shown that there is no dissolved phase impact to groundwater from the LNAPL. In addition, Chevron has recently collected a groundwater sample from monitoring well RW-11 located within the LNAPL extent (Figure 41). The results did not reveal any exceedances of the GWQC for the COCs (see Appendix G). Based on the data obtained at SWMU 41, Chevron maintains its position that groundwater within SWMU 41 is not impacted and believes an NFA for groundwater is warranted.

6.130 Comment 130

RFI Section: A.2.19, page A-164

Comment Letter Page: 17

Based on the information provided, the proposed NFA for ground water is acceptable to the Department at this time.

Chevron Response

Chevron acknowledges NJDEP's acceptance of the NFA for groundwater.

6.131 Comment 131

RFI Section: A.2.37, page A-314

Comment Letter Page: 17

Based on the information provided, the proposed NFA for ground water is acceptable to the Department at this time.

Chevron Response

Chevron acknowledges NJDEP's acceptance of the NFA for groundwater.

6.132 Comment 132

RFI Section: A.3.1, page A-336

Comment Letter Page: 17

Based on the information provided, the proposed NFA for ground water is acceptable to the Department at this time.

Chevron Response

Chevron acknowledges NJDEP's acceptance of the NFA for groundwater.

6.133 Comment 133

RFI Section: A.3.2, page A-342

Comment Letter Page: 17

Based on the information provided, the proposed NFA for ground water is acceptable to the Department at this time.

Chevron Response

Chevron acknowledges NJDEP's acceptance of the NFA for groundwater.

6.134 Comment 134

RFI Section: A.3.5, page A-363

Comment Letter Page: 17

Based on the information provided, the proposed NFA for ground water is acceptable to the Department at this time.

Chevron Response

Chevron acknowledges NJDEP's acceptance of the NFA for groundwater.

6.135 Comment 135

RFI Section: A.3.12, page A-431

Comment Letter Page: 17

Based on the information provided, the proposed NFA for ground water is acceptable to the Department at this time.

Chevron Response

Chevron acknowledges NJDEP's acceptance of the NFA for groundwater.

6.136 Comment 136**RFI Section: A.3.13, page A-437****Comment Letter Page: 18**

Although Table ES-1 indicates that Chevron is requesting an NFA for this AOC, pg. A-438 of the report indicates that the ground water contamination found in this area will be included in the CMS. The proposal to include this area in the CMS is acceptable to the Department.

Chevron Response

Chevron acknowledges NJDEP's acceptance of their proposal to include the area in the CMS.

6.137 Comment 137**RFI Section: A.4.6, page A-475****Comment Letter Page: 18**

The proposal to re-sample in this SWMU is acceptable to the Department.

Chevron Response

Chevron acknowledges NJDEP's acceptance of the proposal to resample the peat layer at SWMU 26 to determine if TOL is present. During the SRFI, soil boring S2323 was advanced to specifically address the potential for TEL impacts to soil at SWMU 26. Soil sample S2323J1 was specifically collected and analyzed for TEL at this location. No TEL was detected in this sample. A full description of SRFI soil investigation activities at SWMU 26 in AOI 2 is presented in Section 5.2.2.

6.138 Comment 138**RFI Section: A.4.8, page A-484****Comment Letter Page: 18**

The proposal for no further action at this SWMU is not acceptable at this time. Chevron shall collect a ground water sample at the location of S1421 (a soil boring at which sheen was identified). The sample shall be analyzed for TCL VOC, TCL SVOC and TAL.

Chevron Response

Chevron agrees to collect a groundwater sample from the zone in S1421 where a petroleum sheen and odor were identified. During the SRFI, two temporary wells (H1007 and H1019) were installed in the vicinity of boring S1421 (see Figure 19). Since the groundwater sample from H1007 was not filtered for metals prior to laboratory analysis, Chevron installed H1019 adjacent to H1007 and collected a metals sample using porous media (see Section 5.4.7). Appendix G presents all laboratory analytical data for all temporary and permanent groundwater monitoring wells, including dissolved metals concentrations, and their respective SRFI Evaluation Criteria.

On December 13, 2007, a groundwater grab sample was collected from the 4.0 to 6.0 ft. bgs interval, and analyzed for VOCs, SVOCs, and metals. No VOCs or SVOCs were detected in concentrations exceeding the SRFI Evaluation Criteria. In addition, no benzene was detected above the MDL of 0.5 µg/L. Several dissolved metals were detected in concentrations exceeding the SRFI Evaluation Criteria; however, sample H1007 was collected from porous media for metals prior to laboratory analysis. See Figure 37 for the distribution of benzene in groundwater at SWMU 36.

As a result, Chevron collected a groundwater sample for TAL metals analysis from H1019 on January 9, 2007 that was properly collected from porous media. The well was screened from 3.0 to 6.0 ft. bgs across the water table. The only exceedance for metals that was not aluminum, iron, or manganese was cobalt. The cobalt value of 5.5 µg/L was slightly above the RFI Evaluation Criteria of 5 µg/L.

Chevron believes there is adequate number of wells (e.g., SB-14, SB-17, MW-150, etc.) in this area and additional wells are not needed. Chevron plans to continue monitoring COCs in this area and report the findings to EPA and NJDEP.

6.139 Comment 139**RFI Section: A.4.12, page A-510****Comment Letter Page: 18**

Although Table ES-1 indicates that Chevron is requesting an NFA for this AOC, pg. A-512 of the report indicates that the ground water contamination found in this area will be included in the CMS. The proposal to include this area in the CMS is acceptable to the Department.

Chevron Response

Chevron acknowledges NJDEP's acceptance of Chevron's proposal to include the area in the CMS.

6.140 Comment 140**RFI Section: A.4.13, page A-517****Comment Letter Page: 18**

The proposal for no further action at this AOC cannot be accepted at this time. Chevron shall collect a ground water sample at the location of S1420. Benzene contamination was found in soil at this location, therefore; a ground water sample is required to determine if ground water is contaminated with benzene prior to issuing an NFA.

Chevron Response

Chevron conducted an SRFI in the AOC 13 vicinity to characterize potential benzene contamination of groundwater in this based on this comment (see Figure 37). During the SRFI, one shallow temporary monitoring well, H1006, was installed in the vicinity of AOC 13. Temporary monitoring well H1006 was installed by DPT methods and abandoned within 48 hours or less. Continuous macro-core soil samples were obtained for the entire depth of the pilot boring for lithologic description and OVM screening purposes. Temporary well H1006 was constructed of one-inch diameter PVC riser pipe, with a two-foot long, 0.01-inch slot, PVC screen. The screen was set across the water table, or deeper, to intersect impacted soil intervals. No sand pack or bentonite seal was used during temporary well installation and the well was not developed prior to sampling. This temporary well was surveyed as described in the SRFI DWP, with no Form A or Form B well completion forms. A detailed boring log for each SRFI temporary monitoring well location is included in Appendix A.

A groundwater grab sample was collected from the 7.5 to 9.5 ft bgs interval of H1006, and analyzed for VOCs using a dedicated, disposable, 0.5-inch, PVC bailer. The groundwater samples were placed in appropriate laboratory cleaned sample containers and packed in a cooler with ice for laboratory submittal.

Dissolved concentrations of benzene (28 µg/L), chlorobenzene (560 µg/L), and chloroethane (110 µg/L) were detected in concentrations exceeding the SRFI Evaluation Criteria (1 µg/L, 50 µg/L, and 100 µg/L, respectively). Figure 37 depicts the distribution of benzene in groundwater in the vicinity of AOC 13 based on H1006 and surrounding wells sampled in 2007. The direction of groundwater flow is toward the east into the bulkhead that separates the EY and the Arthur Kill. Therefore, with regard to Comment 140, the presence of dissolved contaminants in this area is confirmed, and no further horizontal delineation of dissolved or adsorbed contamination can be conducted in this area due to the close proximity of the bulkhead. Chevron rescinds the request for an NFA. This area will be further evaluated under the CMS.

6.141 Comment 141

RFI Section: A.4.18, page A-597

Comment Letter Page: 18

Based on the information provided, the proposed NFA for ground water is acceptable to the Department at this time.

Chevron Response

Chevron acknowledges NJDEP's acceptance of the NFA for groundwater.

6.142 Comment 142

RFI Section: A.4.21, page A-620

Comment Letter Page: 18

Based on the information provided, the proposed NFA for ground water is acceptable to the Department at this time.

Chevron Response

Chevron acknowledges NJDEP's acceptance of the NFA for groundwater.

6.143 Comment 143**RFI Section: page B-3****Comment Letter Page: 18**

Chevron indicates that a formal PAOC SI report will be submitted to the Department for review and comment. This proposal is acceptable to the Department.

Chevron Response

Chevron acknowledges NJDEP's acceptance of the proposal. The PAOC Report was submitted to EPA and NJDEP in June 2007.

6.144 Comment 144**RFI Section: General****Comment Letter Page: 18**

Spent refinery catalysts have been deposited across various areas of the refinery. The Department recommends that the USEPA determine if these spent catalysts are hazardous waste or listed hazardous waste so that an appropriate corrective measure may be selected for areas where the catalysts have been deposited. In addition, the catalysts themselves may require remediation regardless of waste status.

Chevron Response

These spent refinery catalysts are not listed hazardous waste according to RCRA regulations. The CMS PDI Report will provide the location and findings of soil samples found to be characteristically hazardous in the vicinity of SWMU 40.

6.145 Comment 145

RFI Section: General
Comment Letter Page: 18

All monitor wells shall be constructed, maintained and abandoned in accordance with N.J.A.C. 7:9D-1 et seq.

Chevron Response

Chevron acknowledges NJDEP's comment.

6.146 Comment 146

RFI Section: General

Comment Letter Page: 18

Chevron shall inform the NJDEP 14 days in advance of performing field work so that an NJDEP representative may be present.

Chevron Response

Chevron acknowledges NJDEP's comment.

6.147 Comment 147**RFI Section: 9.3****Comment Letter Page: 18**

Background locations shall be clearly identified. While the text infers locations SED 9, 10 and 16 are background locations, it is unclear whether there are others (i.e., SED 11). The range of background data from the Woodbridge and Spa Springs Creeks should be compared to the range of site related data in those Creeks. The range of background data from the Arthur Kill should be compared with the range of site-related data from the Kill.

Chevron Response

The background BEE sediment and surface water sample locations in Section 9.0 of the RFI are shown in Table 70.

Table 70. BEE Sample Locations

Water Body	Background Sample
Spa Spring Creek	SED 11
Woodbridge Creek	SED 09 and 10
Arthur Kill	SED 16 and 17

The original sediment data tables and figures were included in the December 2003 RFI report. As requested by the NJDEP, the range of data from the background locations was compared to the range of data from samples collected adjacent to Chevron (i.e., near-site data). A list of the samples included in the “background” and “near-site” data groupings is provided in Table 71; the summary of background and near-site data ranges are provided on Table 72 through Table 74. A simple comparison of these data demonstrates that many of the sediment constituents of potential environmental concern (COPECs) are present in background sediments, with some at relatively high concentrations. It should be noted that sediments are often semi-transient, exhibiting complex, episodic transport-deposition-resuspension dynamics. Thus, the quantitative presence of contaminants (i.e., concentrations) may be of less importance than the qualitative presence (i.e., list of contaminants) in evaluation of background conditions.

Collection and analysis of additional background sediment samples and integration of regional investigations by others will be included in subsequent investigations to the BEE as discussed in Chevron’s response to Comment 5.

Table 71. BEE Background and Near-Site Data Groupings

Arthur Kill		Spa Spring Creek		Woodbridge Creek	
Background Samples	Near-Site Samples	Background Samples	<i>Near-Site Samples</i>	Background Samples	Near-Site Samples
SED-16-C/6-12	SED-13-C/6-12	SED-11-C/6-12	SED-08-A/6-12	SED-10-A/6-12	SED-06-A/6-12
SED-17-C/6-12	SED-13-C/6-12D		SED-08-C/6-12	SED-10-B/6-12	SED-06-B/6-12
	SED-14-C/6-12		SED-07-A/6-12	SED-10-C/6-12	SED-06-C/6-12
	SED-18-C/6-12		SED-07-B/6-12	SED-09-A/6-12	SED-05-A/6-12
	SED-15-C/6-12		SED-07-C/6-12	SED-09-B/6-12	SED-05-B/6-12
				SED-09-C/6-12	SED-05-C/6-12
				SED-09-C/33-39	SED-04-A/6-12
					SED-04-A/39-45
					SED-04-B/6-12
					SED-04-C/6-12
					SED-03-A/6-12
					SED-03-B/6-12
					SED-03-C/6-12
					SED-03-C/12-18
					SED-03-C/30-36
					SED-02-A/6-12
					SED-02-B/6-12
					SED-02-B/6-12D
					SED-02-C/6-12
					SED-01-A/6-12
					SED-01-B/6-12
					SED-01-C/6-12

Table 72. Arthur Kill Background Comparisons

Contaminant of Concern	Near-Site Sample Range	Background Sample Range	No. Samples > Background /No. Samples	ER-L	No. Samples > ER-L/ No. Samples	ER-M	No. Samples > ER-M/ No. Samples
2-Methylnaphthalene	0.064 - 0.085	0.065 - 0.67	0/5	0.07	1/5	0.67	0/5
Acenaphthylene	0.12 - 0.15	0.15 - 0.59	0/5	0.044	5/5	0.64	0/5
Acenaphthene	0.04 - 0.46	0.027 - 3.9	0/5	0.016	5/5	0.5	0/5
Fluorene	0.053 - 0.21	0.05 - 1.2	0/5	0.019	5/5	0.54	0/5
Phenanthrene	0.28 - 0.36	0.2 - 2.2	0/5	0.24	5/5	1.5	0/5
Anthracene	0.26 - 0.31	0.25 - 2.4	0/5	0.085	5/5	1.1	0/5
Fluoranthene	0.18 - 1.3	1 - 6.4	0/5	0.6	4/5	5.1	0/5
Pyrene	0.24 - 1.6	1.3 - 7.3	0/5	0.665	4/5	2.6	0/5
Benzo(a)anthracene	0.52 - 0.65	0.44 - 3.7	0/5	0.261	5/5	1.6	0/5
Chrysene	0.59 - 0.94	0.7 - 3.8	0/5	0.384	5/5	2.8	0/5
Benzo(k)fluoranthene	0.26 - 0.44	0.33 - 1.2	0/5	0.24	5/5	1340	0/5
Benzo(a)pyrene	0.6 - 0.85	0.65 - 3.2	0/5	0.43	5/5	1.6	0/5
Indeno(1,2,3-cd)pyrene	0.3 - 0.64	0.36 - 1.6	0/5	0.2	5/5	320	0/5
Dibenzo(a,h)anthracene	0.084 - 0.15	0.094 - 0.47	0/5	0.063	5/5	0.26	0/5
Benzo(g,h,i)perylene	0.26 - 0.63	0.33 - 1.7	0/5	0.17	5/5	320	0/5
Total PAHs	4.4 - 9.2	7 - 45	0/5	4	5/5	45	0/5
Arsenic	28.3 - 35.8	46.7 - 107	0/5	8.2	5/5	70	0/5
Cadmium	2.2 - 2.6	2.3 - 5.9	0/5	1.2	5/5	9.6	0/5
Chromium	116 - 134	140 - 198	0/5	81	5/5	370	0/5
Copper	257 - 302	413 - 587	0/5	34	5/5	270	2/5
Lead	194 - 230	291 - 322	0/5	47	5/5	218	1/5
Mercury	2.4 - 3.2	2.6 - 7	0/5	0.15	5/5	0.71	5/5
Nickel	45.1 - 52.3	59.7 - 64.3	0/5	21	5/5	52	1/5
Silver	4.2 - 5.2	2.4 - 7.9	0/5	1	5/5	3.7	5/5

Table 72. Arthur Kill Background Comparisons

Contaminant of Concern	Near-Site Sample Range	Background Sample Range	No. Samples > Background /No. Samples	ER-L	No. Samples > ER-L/ No. Samples	ER-M	No. Samples > ER-M/ No. Samples
Zinc	361 - 393	405 - 617	0/5	150	5/5	410	0/5

Concentrations shown in parts per million.

ER-L = Effects Range – Low (NJDEP Guidance for Sediment Quality Evaluation).

ER-M = Effects Range – Medium (NJDEP Guidance for Sediment Quality Evaluation).

Table 73. Woodbridge Creek Background Comparisons

Contaminant of Concern	Near-Site Sample Range	Background Sample Range	No. Samples > Background /No. Samples	ER-L	No. Samples > ER-L/ No. Samples	ER-M	No. Samples > ER-M/ No. Samples
Benzene	<0.13 - 20	<0.15 - 3	3/22	0.34	3/22	--	--
Toluene	<0.13 - 2.9	<0.15 - 1.1	1/22	2.5	1/22	--	--
Ethylbenzene	<0.13 - 5.5	<0.15 - 6.6	0/22	1.4	2/22	--	--
Xylenes	<0.13 - 27	<0.15 - 29	0/22	0.12	4/22	--	--
Naphthalene	0.0041 - 10	0.0018 - 2.9	2/22	0.16	4/22	2.1	2/22
2-Methylnaphthalene	0.0034 - 39	0.0009 - 10	1/22	0.07	4/22	0.67	3/22
Acenaphthylene	0.0012 - 1.2	0.0049 - 0.49	2/22	0.044	16/22	0.64	2/22
Acenaphthene	0.0015 - 2.8	0.0008 - 0.94	2/22	0.016	16/22	0.5	3/22
Fluorene	0.003 - 5.8	0.0012 - 1.9	2/22	0.019	16/22	0.54	3/22
Phenanthrene	0.011 - 11	0.011 - 9.1	2/22	0.24	14/22	1.5	6/22
Anthracene	0.003 - 1.3	0.017 - 1.6	0/22	0.085	17/22	1.1	3/22
Fluoranthene	0.021 - 4.8	0.12 - 2.7	4/22	0.6	17/22	5.1	0/22
Pyrene	0.027 - 8.6	0.24 - 6.5	1/22	0.665	18/22	2.6	8/22
Benzo(a)anthracene	0.0081 - 3.9	0.14 - 3.3	1/22	0.261	17/22	1.6	4/22
Chrysene	0.011 - 7.5	0.14 - 5.5	1/22	0.384	16/22	2.8	3/22
Benzo(k)fluoranthene	0.0056 - 1.3	0.087 - 0.95	3/22	0.24	14/22	1340	0/22
Benzo(a)pyrene	0.01 - 8.5	0.19 - 6.3	1/22	0.43	15/22	1.6	4/22
Indeno(1,2,3-cd)pyrene	0.0076 - 3.6	0.095 - 2.1	1/22	0.2	16/22	320	0/22
Dibenzo(a,h)anthracene	0.0018 - 3.1	0.026 - 2	1/22	0.063	16/22	0.26	7/22
Benzo(g,h,i)perylene	0.011 - 14	0.095 - 9.1	1/22	0.17	19/22	320	0/22
Total PAHs	0.15 - 91	1.4 - 69	2/22	4	18/22	45	2/22
Antimony	<0.88 - 2.9	<0.85 - 7.9	0/22	2*	3/22	25*	0/22
Arsenic	6.2 - 91.7	4.7 - 64.5	2/22	8.2	20/22	70	1/22
Cadmium	0.68 - 13	0.24 - 13	0/22	1.2	15/22	9.6	2/22

Table 73. Woodbridge Creek Background Comparisons

Contaminant of Concern	Near-Site Sample Range	Background Sample Range	No. Samples > Background /No. Samples	ER-L	No. Samples > ER-L/ No. Samples	ER-M	No. Samples > ER-M/ No. Samples
Chromium	20.5 - 166	11.6 - 126	3/22	81	7/22	370	0/22
Copper	17.7 - 8030	47.3 - 572	8/22	34	21/22	270	14/22
Lead	13.5 - 399	35 - 399	0/22	47	20/22	218	8/22
Mercury	0.03 - 5.8	<0.012 - 4	3/22	0.15	18/22	0.71	11/22
Nickel	28.6 - 2480	28.8 - 290	2/22	21	22/22	52	14/22
Silver	<0.2 - 5.4	<0.12 - 3.6	7/22	1	12/22	3.7	6/22
Zinc	88.9 - 2970	184 - 775	1/22	150	19/22	410	11/22

Concentrations shown in parts per million.

ER-L = Effects Range - Low (NJDEP Guidance for Sediment Quality Evaluation).

ER-M = Effects Range - Medium (NJDEP Guidance for Sediment Quality Evaluation).

*Screening value as provided by the National Oceanic and Atmospheric Administration's Screening Quick Reference Tables.

Table 74. Spa Spring Creek Background Comparisons

Contaminant of Concern	Near-Site Sample Range	Background Sample Range	No. Samples Background /No. Samples	ER-L	No. Samples ER-L/ No. Samples	ER-M	No. Samples ER-M/ No. Samples
Acenaphthylene	<0.0024 - 0.083	<0.0049	1/5	0.044	1/5	0.64	0/5
Acenaphthene	<0.013 - 0.017	<0.0049	1/5	0.016	1/5	0.5	0/5
Fluorene	<0.013 - 0.031	0.0059	1/5	0.019	1/5	0.54	0/5
Phenanthrene	0.018 - 0.31	0.011	1/5	0.24	1/5	1.5	0/5
Anthracene	<0.013 - 0.13	<0.0049	1/5	0.085	1/5	1.1	0/5
Benzo(a)anthracene	<0.013 - 0.29	0.0097	1/5	0.261	1/5	1.6	0/5
Chrysene	0.017 - 0.39	0.011	1/5	0.384	1/5	2.8	0/5
Benzo(a)pyrene	<0.013 - 0.45	0.0061	1/5	0.43	1/5	1.6	0/5
Indeno(1,2,3-cd)pyrene	<0.014 - 0.37	0.0058	1/5	0.2	1/5	320	0/5
Dibenzo(a,h)anthracene	<0.013 - 0.15	<0.0049	1/5	0.063	1/5	0.26	0/5
Benzo(g,h,i)perylene	<0.013 - 0.74	<0.0049	2/5	0.17	2/5	320	0/5
Total PAHs	0.135 - 4.891	0.1	5/5	4	1/5	45	0/5
Antimony	<3.4 - 5.8	<1.7	1/5	2	1/5	25	0/5
Arsenic	6.2 - 164	10	3/5	8.2	4/5	70	1/5
Cadmium	0.31 - 2.5	1.6	1/5	1.2	2/5	9.6	0/5
Chromium	15 - 133	37.7	1/5	81	1/5	370	0/5
Copper	8.2 - 494	23.4	2/5	34	2/5	270	1/5
Lead	7.7 - 656	22.7	1/5	47	1/5	218	1/5
Mercury	0.048 - 2.6	<0.026	1/5	0.15	1/5	0.71	1/5
Nickel	17 - 85.1	32.9	3/5	21	4/5	52	2/5
Silver	0.48 - 2.1	<0.24	1/5	1	1/5	3.7	0/5
Zinc	58.4 - 1140	106	2/5	150	2/5	410	2/5

Concentrations shown in parts per million.

ER-L = Effects Range - Low (NJDEP Guidance for Sediment Quality Evaluation).

ER-M = Effects Range - Medium (NJDEP Guidance for Sediment Quality Evaluation).

6.148 Comment 148**RFI Section: 9.3****Comment Letter Page: 18**

Frequency of detection should not be used to cull potential COCs, since "hot spot" areas may be present and require further evaluation. For example, the significance of BTEX contamination in sediments is diminished, based on "low frequency", yet the ppm-levels exceed screening criteria by two orders of magnitude and these contaminants were identified as site-related in Table 9-2. Further investigation with a more sensitive sampling technique (i.e., diffusion bag samplers) may be warranted. Another example is the elimination of copper from further concern in sediments based on low frequency of detection in soils, even though copper is elevated in 37/42 sediment samples and severely elevated in several (see comment below). Chevron shall reexamine all data and reinstate potential COCs that were culled based on frequency of detection as appropriate.

Chevron Response

Review of analytical detection frequency is a valuable and necessary data evaluation tool; however, frequency of detection alone was not used to cull potential COPECs in the BEE. The NJDEP's concern regarding hot-spots appears exaggerated by referring to "BTEX" as "exceeding the screening criteria by two orders of magnitude". Actually, only one of the BTEX compounds, xylene, was detected at that level. Benzene was near, but less than two orders of magnitude above the criterion. Ethylbenzene was much less than half of an order of magnitude above the criterion and toluene was only slightly over the criterion in only one sample. It should be noted that benzene and xylene were not culled from the list, but were included in the list of COPECs identified by the BEE, and carried through the BEE process including evaluation of migration pathways. The NJDEP inappropriately groups these compounds together and implies, by using them as an example, that constituents were culled from the list of COPECs by mere consideration of detection frequency alone.

The NJDEP offers copper as another example of how low frequency of detection should not be used to cull COPECs. Again, frequency of detection alone was not used to cull potential COPECs in the BEE. In the case of copper, there were several reasons given, in addition to the low detection frequency in on-site soils, to support culling this element from the list of COPECs, including its absence in groundwater, presence in background sediment samples, and significant off-site sources that likely contributed copper and other COPECs detected in the sediments and surface water. Also, the NJDEP references the high copper detection frequency and high concentrations in sediments. However, it should be noted that just because the copper is elevated and frequently detected in sediments, does not demonstrate a causal link to soils at Chevron. This is especially true when the copper data in on-site soils exhibits such a low frequency of detection above the copper soil criterion, there are no migration pathways for copper translocation from on-site soils to the water body sediments, and when there are other more significant potential sources of copper along the stream reach.

Notwithstanding the above response, the constituents culled from the list of COPECs based in part on low detection frequency will be compared to COCs in potential on-site source areas and potential migration pathways, and reinstated only if warranted and as appropriate.

The results of this re-evaluation will be included in a Supplemental Ecological Evaluation Report. Chevron is proposing to defer the submittal of the Supplemental Ecological Report pending obtaining additional groundwater quality from the on-site monitoring well network and incorporate additional soils data generated from the Corrective Measures Study. This will provide Chevron with a more rigorous data base from which to identify COCs.

6.149 Comment 149**RFI Section: 9.3.6****Comment Letter Page: 19**

Nine contaminants were retained as COPECs (antimony, arsenic, lead, nickel, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzene and xylenes in sediment and nickel in surface water). The list was culled further in Section 9.5.4, Conclusions and Recommendations, to a formal general recommendation for further evaluation of SVOCs and metal COPECs in the Woodbridge Creek". These conclusions must be revised after data are reexamined pursuant to the NJDEP's comment above. In addition, this section should be revised to highlight inorganic "hot spots", especially copper and zinc at location SED 3C and SED 5C. These contaminants were identified as site-related (as per Table 9-2). Copper is 200 times the ERL and zinc is 20 times the ERL at location SED 5C, and both are elevated above the range of background data. These levels are of concern from the standpoint of direct exposure as well as a potential source to downstream sediments. Similarly, total PAR levels at SED 3C are elevated relative to other site related and background locations, and shall be specifically addressed. The list of COPECs that will be retained should be revised pursuant to this comment and the NJDEP comment above, and clearly provided in this section.

Chevron Response

The NJDEP's reference to copper and zinc being identified as "site-related" is taken out of context with the overall evaluation. Table 9-2 included an initial list of COPECs, and does not represent the final COPEC list developed at the conclusion of the COPEC review. Later in Section 9.3.6 of the RFI, where conclusions are provided after review of all the data, copper and zinc are not included in the list of potentially site-related COPECs. The COPECs must be qualified as "potentially site-related" because, although both metals are found in the off-site sediments and in on-site soils, there is no migration pathway established and there are many other sources for these elements in the sediment. In fact, the data do not provide a basis to conclude that copper and zinc in the water body sediments are in any way site-related; all of the metals in sediments may derive entirely from other sources. The BEE identifies several such sources, a number of which represent significant potential sources for COPECs - especially metals that are present in the sediment.

Notwithstanding the above response, the conclusions regarding COPECs will be revised pursuant to the re-evaluation described in the response to Comment 148 above. The data evaluation will also include a review of the inorganic "hot spots" focused on copper and zinc, and total PAH concentrations in sediments. These revisions will be incorporated in subsequent investigations to the BEE as discussed in Chevron's response to Comment 5.

6.150 Comment 150**RFI Section: 9.3.6****Comment Letter Page: 19**

Review of Figures 9-6, 9-7 and 9-8 indicate visible staining at all six sample locations in the Woodbridge Creek and reference location SED 9. The conclusions of the COC section should highlight the need for further investigation of sediment cores where staining and petroleum odors were identified. This shall be addressed pursuant to N.J.A.C. 7:26E-6.1(d) whereby Chevron is responsible for remediation of free and/or residual petroleum product, or containment when treatment or removal are not practicable, regardless of depth, the presence/absence of product shall be determined by methods identified in N.J.A.C. 7:26E-2.1(a)11. This section of the regulation includes methodologies such as ultraviolet fluorescence, soil-water agitation procedures, centrifuging and hydrophobic dye testing, gross observations such as visual staining, sheens, droplets, squirting NAPL, odors etc. are important additional information. As an aid to delineation of product, the NJDEP typically requires performance of Total Petroleum Hydrocarbon (TPHC) analysis via method NJDEP OQA-QAM-025-10/01 (Revision 5) or EPA method 418.1 and recommends sediments with TPHC results >3000 ppm to be investigated for product as in 2.1(a)11 above. The TPHC method shall use a standard capable of quantifying both aliphatic and aromatic hydrocarbons.

Chevron Response

Subsequent investigations to the BEE as discussed in Chevron's response to Comment 5 will include details for further investigation of the staining and petroleum odors reported in many sample locations in Woodbridge Creek. The investigation will be conducted using TPHC analysis by Method NJDEP OQA-QAM-025-10/01 (latest NJDEP approved revision) and a soil-water agitation procedure for free and/or residual product for samples containing TPHCs greater than 3,000 ppm. The investigation will include sediments from background and near-site sampling locations.

6.151 Comment 151**RFI Section: 9.4****Comment Letter Page: 19**

The existence of the storm water network notwithstanding, if more detailed information is available, or a historic migration path was likely, to link specific SWMUs/AOCs with contaminants found in surface water bodies, it should be provided (i.e., historic soil runoff prior to emplacement of the storm water system, flood events or historic direct discharges etc.). Lack of information regarding operations/potential contaminant migration from the North Field Extension must be identified as a data gap.

Chevron Response

The observed metals and petroleum-related substances are not associated with active discharges or migration pathways, based on inspections and groundwater data from monitoring wells located along the Woodbridge Creek. Historical site data was used to guide development of the sediment and surface water sampling plan. It should be noted that the sediment transects and surface water locations described in the BEE were provided to the NJDEP prior to sample collection, and the sampling locations and overall plan was discussed and approved during a meeting with the NJDEP prior to sample collection. The sampling plan and precursory discussions with the NJDEP included historical migration pathways (e.g., historical aerial photographs) that formed the basis for the selection of transect locations. Therefore, Chevron believes that the investigation adequately considered the historical migration pathways. There is no additional historical information other than what has been used already to evaluate potential migration pathways.

Also, as noted in the previous discussion of Comment 1, the NFE was never included in Chevron's Refinery operations and was not included within the scope of the RFI Report; ecological evaluation of the NFE is addressed in the March 1, 2005 RIR (Roux, 2005).

Notwithstanding the above responses, the sediment data will be re-evaluated to identify any potential historical links to SWMUs/AOCs and the list of COPECs will be updated if necessary. Also, the 2005 RIR will be reviewed, and pertinent data and findings will be summarized in the context of Chevron's BEE. A summary of the historical review and review of the 2005 RIR will be included in subsequent investigations to the BEE as discussed in Chevron's response to Comment 5.

6.152 Comment 152**RFI Section: 9.5.4****Comment Letter Page: 19**

This section shall identify data gaps that will be addressed in the future evaluations, (i.e., need for data from areas of intertidal estuarine wetlands identified on pg. 333 and Figure 9-3). The need for characterization of the North Field Extension should be highlighted, since numerous creeks/ditches discharging to the Woodbridge Creek are indicated on Figures 9-6, 9-7 and 9-8. The need for further investigation of sediment locations exhibiting sheen and odors, per the NJDEP comments above must be indicated.

Chevron Response

As noted in the RFI Report, additional ecological evaluation is recommended for selected COPECs in Woodbridge Creek sediments. Data gaps that will be addressed in future investigations include, TPHC analysis of sediment samples (as described in Comment 150 above) and further investigation of sediment COPECs in background and hot-spot areas, including sediments in adjacent intertidal wetland areas. The list of COPECs to be included as part of the future investigations will be revised to include constituents, as appropriate, based on the additional data review as described above. The data gaps will be summarized and addressed.

6.153 Comment 153**RFI Section: 9.5.4****Comment Letter Page: 19**

Chevron should be aware that the NJDEP concurs with the conclusion to further evaluate Woodbridge Creek, however Spa Spring Creek and the North Field Extension must also be included. In addition to the "SVOC and metal COPECs" identified for further evaluation in Section 9.5.4, the NJDEP recommends that the analyses include BTEX compounds, TPHC and a more comprehensive list of metals. The BEE should be revised per the above comments.

Chevron Response

Based on the NJDEP's comment, the NJDEP agrees with the December 2003 RFI Report recommendation for further evaluation of Woodbridge Creek sediments. However, the requirement to include Spa Spring Creek and the NFE needs clarification. One of the technical reasons for not including VOCs in future sediment sampling was that BTEX compounds were only detected above Sediment Screening Guidelines (SSGs) in Woodbridge Creek sediments. Thus, additional evaluation of VOCs in Spa Spring Creek is not warranted.

7. Conclusions and Recommendations

7.1 Conclusions

The SRFI for the Perth Amboy Refinery was completed for all SWMUs and AOCs located in the NF/MY and EY of the Refinery with the exception of SWMU 32 (PCB Storage Warehouse) and SWMU 51 (Oily Soil Pad). Chevron investigated these two SWMUs in the Fall of 2007 and will report those findings separately. The primary purpose of the SRFI was to complete the delineation of the nature and extent of contamination from the SWMUs and AOCs at the Refinery. This SRFI was completed in accordance with Chevron's HSWA Permit NJD081982902.

Since 1994, the following activities have been completed site-wide during both the RFI and the more recent SRFI (October 2006 through March 2007):

- 1436 soil borings;
- 2309 soil samples collected and analyzed;
- 67 MIP survey points (SRFI and AOC 36);
- 19 XRF survey points;
- 53 CPT vertical stratigraphic profiles (AOC 36);
- 524 temporary shallow groundwater monitoring wells installed;
- 176 permanent shallow groundwater monitoring wells installed;
- 22 permanent deep groundwater monitoring wells installed;
- 13 piezometers installed;
- 15 temporary off-site soil gas monitoring points (AOC 36)
- 19 LNAPL recovery wells installed;
- Almost 2,000 groundwater samples collected and analyzed;
- 17 surface water samples collected and analyzed;
- 42 sediment samples collected and analyzed; and
- Visualization modeling of all historical and SRFI data.

This section presents the conclusions and recommendations of the SRFI. Based on the results of the investigations conducted as part of the SRFI, Chevron has been able to characterize and evaluate the nature and horizontal and vertical delineation of surface and subsurface contamination at the Refinery.

7.1.1 Soils

The SRFI has confirmed the COCs found during previous investigations (e.g., RFI). In addition, the SRFI has delineated both horizontally and vertically all contaminated soil areas site-wide. Through data visualization modeling and a strategic decision-based sampling program, Chevron has completed its soil investigations of all existing AOCs and SWMUs site-wide, with the exception of SWMU's 32 and 51. Chevron investigated these two SWMUs in the Fall of 2007 and will report those findings separately.

COCs in soil are primarily found in the fill materials at varying depths site-wide near waste management areas or operational areas. The fill material is composed primarily of low permeability silts and clays with some discontinuous lenses of sand. Across most of the site, the fill material is underlain by a naturally-occurring layer of low permeability clay (Clay Horizon A) or a glacial till composed of silts and clay with some sand lenses.

The primary COCs in soil include petroleum-related VOCs, SVOCs, and metals as listed in Table 75.

Table 75. Soil Constituents of Concern

VOCs	SVOCs	Metals
Benzene*	2,4-Dimethylphenol	Arsenic*
Cyclohexane*	Benzo(a)anthracene*	Lead*
Ethylbenzene*	Benzo(a)pyrene*	
Isopropylbenzene	Benzo(b)fluoranthene*	
Toluene	Benzo(k)fluoranthene*	
Xylenes (total)*	Bis(2-ethylhexyl)phthalate	
	Carbazole*	
	Dibenzo(a,h)anthracene*	
	Indeno(1,2,3-cd)pyrene	
	Naphthalene*	

*Compound confirmed during SRFI.

Benzene and several PAHs comprise the majority of facility-related exceedances noted through the years. An analysis of the numerous soil samples revealed benzene as the primary indicator analyte for VOCs in soils at the Refinery. A similar analysis indicates benzo(a)pyrene as the primary indicator for SVOCs in soils at the Refinery associated with the fill material. The occurrence of benzo(a)pyrene site-wide is primarily sporadic with the exception of the northwestern corner and central portion of the NF near NF3A, where it is more common. Various metals have also been noted in exceedance of the soil evaluation criteria; however, with the exception of lead found at TEL sites and to a lesser degree antimony, the presence of metals does not appear to correlate well to areas impacted by historic operations. During the SRFI, frequent occurrences of arsenic were found in the soils in the southeastern portion of the EY. Investigations conducted by ASARCO revealed similar results on their property in that area adjacent to the Chevron EY property (see Appendix K). Since ASARCO once operated a smelter on their

property with large stacks, the arsenic is most likely from past operations on the ASARCO site.

Of the COCs, PAHs and metals have relatively low mobility potential in the unsaturated zone due to their low solubilities and high adsorption to soil (most of the PAHs detected have relatively high K_{ow} coefficients). Therefore, these constituents are a potential concern for direct contact that can be addressed by institutional and/or engineered controls during Chevron's CMStudy.

As part of the SRFI, several TEL areas were confirmed and delineated at the site. In general, the TEL burials provided the highest concentrations of target analytes at the site. However, these burials were found to be of limited spatial distribution. During the SRFI, no TEL was detected, only lead. An XRF survey of SWMU 20 indicated that the lead contamination is generally shallow, at an average depth of approximately 4.5 ft. bgs within the fill material, and bound by the native material underneath.

In summary, contaminated soil areas at the site were delineated during the SRFI. Contamination exists primarily in the fill zone and is composed primarily of petroleum constituents. Refinery-related soil contamination is limited in its aerial extent and does not extend off-site.

7.1.2 LNAPL

LNAPL has been found in the subsurface at 17 locations. Based on GC fingerprinting, the LNAPL is highly weathered, resulting in a relatively viscous material with limited remaining soluble constituents. It was not uncommon to obtain a soil sample adjacent to an LNAPL zone for laboratory analysis based on color, PID readings or other field screening techniques and have no exceedances noted. This result was not unexpected, given the long history of refining operations at the site and the implementation of improved spill control measures and operating procedures over the past several decades. LNAPL is therefore historical in nature and not the result of ongoing operation at the Site.

Subsurface investigations conducted to evaluate these areas were successful in delineating the nature and extent of the LNAPL. All of the 17 LNAPL areas are limited to within the site boundary. The highly weathered LNAPL has limited mobility in the subsurface. When present, dissolved phase organic contamination (typically benzene) emanating from the LNAPL areas appears to attenuate quickly.

7.1.3 Groundwater

The RFI and SRFI groundwater investigations included the installation of approximately 524 temporary wells, 13 piezometers, 176 permanent shallow wells, and 22 permanent deep wells. The first water-bearing zone encountered exists within the fill material placed on the site for construction purposes. The depth to water is relatively shallow, typically within 10 feet of the ground surface. In general, the shallow groundwater flows to the

northeast, discharging to adjacent saline and tidal flowed surface water bodies (the Arthur Kill and the Woodbridge Creek). Measured hydraulic gradients are relatively flat, with an average of approximately 0.01 ft/ft. Hydraulic conductivities within the fill are anticipated to be in the range of 1×10^{-4} cm/sec. This translates into relatively slow groundwater seepage velocity rates.

The primary COCs in groundwater include VOCs, SVOCs, and metals as listed in Table 76.

Table 76. Groundwater Constituents of Concern

VOCs	SVOCs	Metals
Benzene	Benzo(a)anthracene	Arsenic
Bromodichloromethane	Benzo(a)pyrene	Antimony
Cyclohexane	Benzo(b)fluoranthene	Cadmium
Chloroethane*	Bis(2-ethylhexyl)phthalate	Cobalt
Chlorobenzene	Carbazole	Lead
Cis-1,2-dichloroethylene*	Dibenzofuran	Nickel
1,1-Dichloroethane*	2,4-Dimethylphenol	Thallium
1,1-Dichloroethylene*	2-Methylnaphthalene	Other
Ethylbenzene	Methyl ethyl ketone	Ammonia Nitrogen
Methylcyclohexane	Napthalene	Chloride
Tetrachloroethene*	o-Cresol	
Toluene	p-Cresol	
1,1,1-Trichloroethane*		
1,1,2-Trichloroethane*		
Trichloroethylene*		
Vinyl Chloride*		
Xylene		

*Compounds found at AOC 36 only.

Benzene, arsenic, and lead were the most frequently detected COCs when SRFI Evaluation Criteria exceedances were detected in shallow groundwater monitoring wells. As presented in this report, Chevron has completed the horizontal and vertical delineation of contaminants in groundwater site-wide with the exception of AOC 31. For the most part, groundwater contamination is limited to the shallow water-bearing zone encountered within the fill layer. Deep wells screened in the first water-bearing zone beneath the fill and Clay Horizon A confirmed this with the exception of the AOC 31 (Tank Basin 772 Pump Pad) area in the northeast portion of the EY and AOC 36 (Chlorinated Solvent Plume) in the southern portion of the CY.

Since 2003, Chevron has successfully delineated the CVOC plume known as AOC 36. In this case, the CVOC plume is migrating to the southeast through the fill material, but also through paleo-sand channels in the glacial till at depth. The CVOC plume was delineated horizontally and vertically off-site on neighboring properties. Clay Horizon A was found to be absent in this portion of the site. However, the Woodbridge Clay was very prevalent beneath the till which bound the contamination in areas.

With the twenty two deep monitoring wells and three deep piezometers that exist on-site; Chevron has a better understanding of the vertical hydrogeology of the site. For the first time, a deep groundwater contour map can be generated from site-wide gauging events. The direction of groundwater flow follows regional projections, east-northeast toward the Woodbridge Creek and the Arthur Kill. The horizontal gradients varied across the NF/MY, from 0.000475 (NF6) to 0.00817 (NF2). In the EY, the horizontal gradients varied from 0.00675 on the western side (AOI 1) to 0.00947 on the eastern side (AOI 2).

The vertical gradients across the site ranged from 0.01063 in the MY NF 6 Area (RW-42/MW-239) to 0.6364 in the CY AOC 36 Area (MW-101/MW-184). Seventeen of the 21 shallow/deep well pairs analyzed were calculated to have downward flow. The four remaining well pairs exhibiting upward flow were located in the MY NF2, NF5, and NF6 Areas.

In all but one case (AOC 31), when VOCs, SVOCs, and metals were evident in concentrations exceeding the SRFI Evaluation Criteria in the shallow monitoring wells, the corresponding deep wells did not contain VOC or SVOC exceedances. The analytical data, coupled with lithologic information from each boring, indicate no evidence of contaminant migration between the first shallow water-bearing zone and first native water-bearing zone across these areas other than AOC 31, despite the number of well pairs calculated to have downward flow.

In summary, vertical delineation of groundwater has been achieved in each of the areas discussed above based upon an analysis of the deep well/shallow well pair data with the exception of AOC 31 (Tank Basin 772 Pump Pad) in the EY. Chevron will pursue this finding and additional nested monitoring well pairs will be installed across the Tank 772 Area in the vicinity of MW-250, to obtain full vertical and horizontal delineation of dissolved phase contaminants at AOC 31.

Based on Chevron's review of environmental investigations conducted on the neighboring properties owned by ASARCO and AHC, Chevron will continue to monitor these off-site activities to support Chevron's groundwater monitoring program in the EY (e.g., SWMU 8 and perimeter well MW-6).

7.2 Recommendations

Table 77 summarizes the SRFI HSWA Permit status of each SWMA, SWMU, and AOC site-wide based on the findings of the SRFI. Since delineation of contaminants is complete sitewide with a few exceptions discussed earlier, most of these units are recommended by Chevron to be further addressed under Chevron's CMS. Chevron also recommends 22 units for NFA regarding soils and 17 units for NFA regarding groundwater based on the findings of this report. In addition, two SWMUs (SWMU 32 and SWMU 51) and one AOC (AOC 31) require further investigation. The findings of these investigations will be reported to EPA and NJDEP in the first quarter of 2008.

Table 77. SRFI HSWA Permit Status

Unit	Designation	Soil Investigation Status	Groundwater Investigation Status
SWMA 1	SWMU 27, 29, 39 & AOC 5, 7	CMS	CMS
SWMA 2	SWMU 28, 30, 38	CMS	NFA Granted
SWMA 3	SWMU 5, 21, 43	CMS	CMS
SWMA 4	SWMUs 46, 47, 48, 49 & AOC 12	CMS	CMS
SWMU 1	North Field Basin (Closure)	Under Closure	Under Closure
SWMU 2	Surge Pond (Closure)	Under Closure	Under Closure
SWMU 3	East Yard Basin (Closure)	NFA Recommended*	NFA Recommended*
SWMU 4	Landfarm (Closure)	NFA Recommended*	NFA Recommended*
SWMU 6	TEL Burial (north - Tank 306)	CMS	CMS
SWMU 7	TEL Burial (east - Tank 305)	CMS	CMS
SWMU 8	TEL Burial (northwest - EYB)	CMS	CMS
SWMU 9	TEL Burial (north - Tank 753)	CMS	CMS
SWMU 10	2 TEL Burials (southwest - Tank 771)	CMS	CMS
SWMU 11A	TEL Burial (along RR tracks)	CMS	NFA Granted
SWMU 11B	2 TEL Burials (along RR tracks)	NFA Recommended*	NFA Granted
SWMU 12	3 TEL Burials (west - Tank 27)	CMS	CMS
SWMU 13	TEL Burial (west - Tank 28)	NFA Recommended*	CMS
SWMU 14	2 TEL Burials (east - Tank 23)	NFA Recommended*	NFA Granted
SWMU 15	TEL Burial (south - Tank 14)	CMS	CMS
SWMU 16	TEL Burial (south - Tank 306)	CMS	CMS
SWMU 17	TEL Burial (east - Tank 301)	CMS	CMS
SWMU 18	TEL Burial (west - Tank 301)	CMS	CMS

Table 77. SRFI HSWA Permit Status

Unit	Designation	Soil Investigation Status	Groundwater Investigation Status
SWMU 19	TEL Burial (west - Tank 326)	CMS	CMS
SWMU 20	TEL Burial (east - Tank 302)	CMS	CMS
SWMU 22	TEL Burial (east - Tank 329)	CMS	CMS
SWMU 24	TEL Weathering (east - Tank 9209)	CMS	CMS
SWMU 25	TEL Burial (northeast - EYB)	NFA Recommended*	NFA Recommended*
SWMU 26	TEL Burial (south - EYB)	CMS	CMS
SWMU 31	Effluent Treatment Plant	NFA Granted	NFA Granted
SWMU 32	PCB Waste Storage Building	Investigation Required	Investigation Required
SWMU 34	Dumpster and Drainage Area	CMS	CMS
SWMU 35	No. 4 Separator (& AOC 6A)	CMS	CMS
SWMU 36	Oil/Water Separator	CMS	CMS
SWMU 40	Old Pond	CMS	CMS
SWMU 41	Drying Area	CMS	NFA Recommended
SWMU 42	East Yard Crude Slab	CMS	CMS
SWMU 44	Unnamed Main Yard Pond	NFA Recommended*	NFA Granted
SWMU 45	Surface Impoundment (south - EYB)	NFA Recommended*	NFA Recommended*
SWMU 51	Oily Soil Pad	Investigation Required	Investigation Required
SWMU 52	TEL Burial (southwest - Tank 13)	NFA Recommended*	CMS
SWMU 53	Potential Discharge - Tank Basin 312	CMS	CMS
AOC 1	Potential Discharge - Tank 1	NFA Recommended*	NFA Recommended*
AOC 2	Potential Discharge - Tank 3	NFA Recommended*	NFA Recommended*
AOC 3	Potential Discharge - Tank 4	NFA Recommended*	NFA Recommended*

Table 77. SRFI HSWA Permit Status

Unit	Designation	Soil Investigation Status	Groundwater Investigation Status
AOC 6A	Oil Material (B26 & B34)	Incorporate into SWMU 35	Incorporate into SWMU 35
AOC 6B	Oily Material (B-29, B-30 & B31)	Incorporate into EY4A	Incorporate into EY4A
AOC 6C	Oily Material (B32 & B33)	NFA Recommended*	NFA Recommended*
AOC 8	Oily & Tarry Material at B-27 & B-28	CMS	CMS
AOC 9A	Contamination at NF-10	NFA Recommended*	CMS
AOC 9B	Contamination at NF-11	NFA Recommended*	CMS
AOC 10	Stained Soil & Gravel Near IAF Tank	CMS	CMS
AOC 13	Oily Fill Material (B-11)	NFA Recommended*	CMS
AOC 14	GWQAP Oily Fill Area III	Incorporate into EY4A	Incorporate into EY4A
AOC 15	Oil Release at Buckeye Pipe Manifold	Incorporate into AOC 8/NF6	Incorporate into AOC 8/NF6
AOC 16	Oily Water Sewer System	CMS	CMS
AOC 17	Potential Discharge - Tank 20	CMS	CMS
AOC 18	Potential Discharge - Tank 2	CMS	CMS
AOC 19	Main Yard Pipeway	CMS	CMS
AOC 20	Aboveground Product Pipe Manifold	NFA Recommended*	NFA Recommended*
AOC 21	Maurer Road Excavation / SS Loading Rack	CMS	CMS
AOC 22	Shops Building GW Contamination	NFA Recommended*	CMS
AOC 23	Tank Basin 327	CMS	CMS
AOC 24	Release at Fire Hydrant (NW-Tank 4)	NFA Recommended*	NFA Granted
AOC 25	Release at Former Cat Cracker	CMS	CMS
AOC 26	East Yard Bunker Slab	Incorporate into EY4B	Incorporate into EY4B
AOC 27	Tank 777 Pipeway	CMS	CMS
AOC 28	Asphalt Plant Tanks	CMS	NFA Granted

Table 77. SRFI HSWA Permit Status

Unit	Designation	Soil Investigation Status	Groundwater Investigation Status
AOC 29	5 Berth	CMS	CMS
AOC 30	Tank 27 Pipeway	CMS	NFA Granted
AOC 31	Tank 772 Pump Pad	CMS	Investigation Required
AOC 32	Tank 16 Basin	CMS	CMS
AOC 33	Tank 314 Basin	CMS	CMS
AOC 34	Tank 315 Basin	CMS	CMS
AOC 35	Tank 771 Basin	NFA Granted	NFA Granted
AOC 36	Chlorinated Hydrocarbons in Groundwater	CMS	CMS
AOC 37	East Yard Gasoline Filters	CMS	CMS
AOC 38	Barge Loading Manifold & G180/181 Naphtha Pumps	CMS	CMS
AOC 39	East Yard Pump House and PRC Loading Rack	CMS	CMS
AOC 40	Tank Basin 22	CMS	NFA Recommended**
AOC 41	Tank Basin 300	CMS	CMS
AOC 42	Tank Basin 310	CMS	NFA Recommended**
AOC 43	Tank Basin 311	CMS	NFA Recommended**
AOC 44	Tank Basin 313	CMS	CMS
AOC 45	Tank Basin 748	CMS	CMS
AOC 46	Tank Basins 749 and 780	CMS	CMS
AOC 47	No. 4 Crude Unit	NFA Recommended**	NFA Recommended**
AOC 48	Isomax Process Plant	CMS	CMS
AOC 49	#3 Rheniformer	CMS	NFA Recommended**

*Indicates that this NFA recommendation was requested previously in the original RFI Report in 2003 or in another submittal to EPA and NJDEP.

**Indicates a new NFA recommendation and that a formal request will follow for each unit.

Furthermore, Chevron proposes the following recommendations based on the findings of the SRFI:

7.2.1 Soils

- Conduct additional investigations of SWMU 32 (PCB Warehouse) in the EY and report findings to EPA and NJDEP;
- Conduct additional investigations of SWMU 51 (Oily Soil Pad) in the MY and report findings to EPA and NJDEP;
- Continue to investigate PAOCs as necessary and report findings to EPA and NJDEP;
- Continue to monitor environmental investigation activities on the neighboring ASARCO property in relation to arsenic in soils at AOI 3 in the EY; and
- Develop a geologic model of the site based on Chevron's extensive database.

7.2.2 LNAPL

- Continue to focus on LNAPL recovery site-wide; and
- Continue to provide annual Stabilization Measures Status Reports to EPA and NJDEP.

7.2.3 Groundwater

- Continue to investigate groundwater contamination at AOC 31 until delineation has been completed and to report findings to EPA and NJDEP;
- Continue monitoring permanent shallow wells and all deep wells site-wide as described in this report;
- Continue quarterly gauging of monitoring wells;
- Improve the monitoring of metals in groundwater site-wide;
- Continue to monitor groundwater activities on the neighboring AHC property in relation to SWMU 8 in the EY;
- Continue to monitor groundwater activities on the neighboring ASARCO property in relation to Chevron's southern property boundary in the EY; and
- Continue to analyze and report groundwater data on a quarterly basis to EPA and NJDEP.

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